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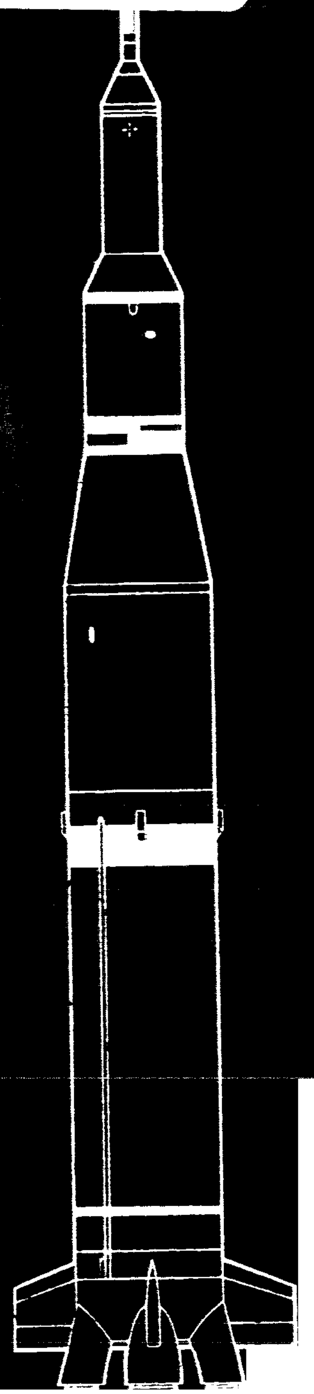

National Aeronautics and Space Administration

Syracuse University

WHAT MANNED SPACE PROGRAM
AFTER REACHING THE MOON?
GOVERNMENT ATTEMPTS TO DECIDE: 1962-1968

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(6222-R-2)

The Research for this Report was Supported by

NASA Research Grant NGL 33-022-090

Syracuse University

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Syracuse, N. Y.

December, 1971

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While the authors have collaborated in the development of all parts of this project and particularly in writing Chapters I and VII, Chapters V and VI and most of Chapter II were written by Emmette S. Redford, Chapters III and IV by Orion F. White.

CHAPTER I

ENIGMAS OF POLITICS IN CONFRONTATION WITH TECHNOLOGY AND SCIENCE

Can technology and science be combined with government on behalf of the community? Can the scientific and technological revolution be directed toward community goals by a political system that evolved under the impact of changes over the past 500 years but that now faces change increasing in a geometric spiral? Can our vision of popular government at last be fully attained, or will it be thwarted at the last phases of a long struggle toward its realization? These issues compel our concern because of the tremendous potentialities of technology in our civilization and because of the apparent self-determinism of expanding technology.

Nowhere are the enormous leaps in technological capability so spectacular at this moment as in manned space flight. Man at Christmas 1968 travelled to the moon, and in July 1969 set foot on its surface. Gratification and awe at these achievements were mixed with wonderment at prospects for the future. We are challenged at such a moment in history to think of the possibilities for the uses and expansions of this technology over a span of years. We are challenged also to think of the processes by which the nation makes its decisions on the uses and expansion of technology. This book is devoted to this latter inquiry. Its purpose is to present and analyze the way the administrative/political institutions of our government handled the issues on uses and expansion of manned space flight technology from 1962 to 1968 and to extrapolate from this experience conclusions on the nature of that process and on the capacity of the political system in confrontation with technology and science.

We must be explicit about the subject and period on which this inquiry is focused. The goal of a lunar landing within the decade was set by President Kennedy and Congress in 1961. This landing was to be effected from Apollo spacecraft launched by a Saturn V rocket. It was a Saturn/Apollo venture and came to be known as the "Apollo" program. Post-Apollo manned flight is a term used herein to apply to all manned flights following the first lunar landing. Decisions with respect to such flights may be made in phases over an indefinite future. Our inquiry is limited to the period from the beginning of attention to post-Apollo manned space ventures to the end of 1968. This might or might not be the end of a phase in manned space planning and programming, but it is a manageable period for intensive analysis, and it is contemplated that a follow-up study of a subsequent period will be made. Our purpose, finally, is not to analyze the issues for the purpose of concluding what the post-Apollo manned space program, if any, should be, but to analyze the way the administrative/political system dealt with the issues and to see what the significance of this process is for a society that will be confronted repeatedly with issues on development and use of technological and scientific capabilities.

Technology, Science, and Government

At the beginning it is necessary to extricate from myriad interacting influences some of the relationships of technology, science and government that have been generated by the scientific and technological revolution. We can look, first, at some of the most obvious internal relationships.

One aspect of change in recent years is the increasing interdependence of technology and science. While earlier technical invention was based upon observation, "common sense," and ingenuity, scientific knowledge is now exploited for technical advantage. Scientific advance, in turn, is facilitated by technology, as is especially well illustrated in space science. These two are now joined in our terminology, as when we refer to "science and technology" or "research and development."

Another change is the institutionalization of technology and science. Early inventions and their utilization occurred in small shops, and were exceptional events, achieved by individuals. Today the systematic methods and trained skills of specialized scientists and engineers are employed in laboratories of business, government, and universities. Now the discovery of new processes and products is a normal result of institutional effort. Teams of workers collaborate and are coordinated by manager-engineers or manager-scientists. In an area like space science and technology, numerous groups of workers may be working in many laboratories and production units on related projects. Project management--calling for the coordination of human skills and production units, the fusion of science and engineering into administration--is crucial in the extension of knowledge and the enlargement of technological capability. Moreover, laboratories and other work units are organized under institutional sponsorship and direction. These institutions--whether industrial, educational, governmental, or quasi-public--have continuity, and they seek new projects as old ones are completed. They create science-industry complexes, with geographical concentrations but with varied and diffuse effects through the communities of science, management engineers, and economic entrepreneurs. This institutional organization expands the capabilities of technology and science, indeed is the foundation of much of the modern technical and scientific capability. It brings with it, moreover, as will be seen in the story which follows, new aggregations and new diversities of interest that seek protection and promotion in those arenas where decisions on the allocation of society's resources are determined.

Particularly significant is the dependence of technology and science since World War II on allocations of resources from government. Government in 1968 spent $17.0 billion on research and development--2 percent of the gross national product and 70 percent of the total expenditures for research and development. In biological science and health technology the public support is dominant, in military-space science and technology, it is almost total. Most of the support is channeled to business, educational, and quasi-public institutions. These are heavily dependent upon government for the maintenance of their institutional programs, and governmental agencies are dependent upon them for achievement of their goals. Thus, government and science and technology are wedded in joint undertakings.

In sum, we see in the twentieth century these three new developments in what might be called the internal world of science and technology: the interdependence of science and technology, the institutionalization of science and technology, and the mutual dependence of government and the science/technology establishment on each other for the survival and expansion of research and technology.

On the world beyond--on culture and the lives of people--the changes also have been great. Because of the ubiquitousness and rapidity of technical innovation Americans have come to accept change as normal in our culture. Whereas in the past men might have been comforted by tradition, stability, security, and peace, they are now pressed to adapt to constant transition. Spectacular revolutions in such areas as transportation and communications technology, nuclear energy, information processes, biological science, and medical capability make us conscious of the dependence of our social values and goals on man's discoveries and their technical application. Few, indeed, would believe that new trends in art, music, and literature, the reform spirit of the New Left, and even the question as to whether "God is dead" are unrelated to the pace of change and to our consciousness of it. There have been other periods in history when great changes occurred in institutions, thought, and the way people lived; but the unprecedented pace of technological development seems to have habituated this age to the fact of change.

Yet the expectancy of change at an ever-accelerating rate is accompanied by a search for security: peace, freedom from want, law and order. And there is discomfort as we wonder whether norms of conduct, social institutions, and the techniques of political management can provide stability and continuity in the evolving society of the future. In short, technological innovation is beset with paradox.

A further impact of science and technology is rising expectation among men of every social class. This is accompanied by a haunting fear that science and technology will destroy opportunity for wholesome living, or even civilization itself. Freedom of all from want is a new dream created by technological advance, but medical technology supports a population explosion that clouds the dream. Technology applied to resources offers vistas of ample supply of material needs, but technology pollutes the soil, water, and air on which the satisfaction of these material wants is based. The compression of space by transportation and communication technology supports a vision of interdependence of peoples and of mutual understanding among them, but the vision fades as it is realized that a single miscalculation of risk by national decision-makers or a single madman may destroy achievement, hope, and life itself over much of the globe. Leisure, the knowledge explosion, and the means of dispersing knowledge to the masses of men--all made possible by technology--create aspirations in increasing numbers of people for intellectual growth and spiritual independence, but new technologies of mass communication threaten us with conformity of thought and a surveillance that may invade even the innermost privacies of life. Science gives us visions of opportunities even to improve the quality of the human species through future generations, but we recoil as we contemplate the potential dominance over individuals that implementation of scientific knowledge would entail.

These uncertainties about our future are magnified by the effects of rapid change on the social fabric and the capabilities for social response. Change may have the effect of shattering old coherences in society and of leaving it with quandaries on the new developments. Let us look briefly at the positions of technology, science and government in the patterns of change, coherence, and quandary.

If we think of science as understanding and technology as action capability, we can see distinctive roles for technology, both in providing social coherence and in shaking old continuities. Technology, by providing the means by which life and hence society is sustained, supplies the unities around which the economic structure of society is built. The unities are not those merely of technological equipment and skill, but are institutional. Organizations are built for structure and use of technology and these interrelate with other organizations in continuing and therefore stable patterns. Moreover, the roles of the technologist are professionalized, as, for example, in the practice of medicine or accounting and the teaching of engineering. These organizations and professions achieve legitimacy in law and opinion, become part of the authority structure of society, and hence stabilize change that occurs through technology.

In addition, there is a kind of self-propelling and self-containing tendency in technological change. Existing organizations and professions serve as media for extending, absorbing, and utilizing or shelving new technology. Once structural and professional coherence for a new technology--such as automobile, airline, or space--is developed, there is effort toward incremental adaptation of new developments to old patterns. There is thus in established social organization a capacity for continuous incremental absorption of changes that are not too radical to be contained and directed by this process.

Nevertheless, rapid growth of technology, particularly that creating large new capabilities, may break down this continuity achieved by institutional absorption. First, technology as it evolves may produce physical changes that make old institutional frameworks obsolete--the automobile being the most obvious and oftnoted example of this social impact of technology. Second, technology often enhances alternatives and capabilities in such a way that it creates ambiguous situations around formerly unambiguous societal, moral or utilitarian standards--the contraceptive pill (especially will this be true with the predicted "post-facto" contraceptive pill) and heart transplants are two recent examples. Developments of these two types may generate institutional flux and moral quandaries before new stabilities are established.

Technology, being by its nature pragmatic, provides no theoretical superstructure beyond its own inherent pragmatism by which man can orient himself to change or make judgments about its social direction. In recent generations we have expected science to provide basic understanding by which we could orient ourselves to reality. Man moved in the nineteenth century toward acceptance of the scientific method as the means of comprehending physical reality. We have a new vocabulary, a new "supply of images," and may believe that we have in science "an absolute able to justify and motivate individual action."1/ In addition to the acceptance of the scientific method we may look to science for coherence in our interpretations of emerging knowledge and even for guidance of individual and social behavior. Thus, just as technology provides some coherence through institutionalization, science provides some coherence in understanding.

1/ Charles E. Rosenberg, "Science and American Social Thought," in Science and Policy in the United States, ed. David D. Von Tassel and Michael G. Hall (Homewood, Ill.: The Dorsey Press, 1966), p. 136.

Yet science also creates disunities and leaves us with quandaries. First, science is inherently open-ended. Its quality is searching for understanding beyond the explanations of the present. Its unity is the scientific method and point of view that accepts this. Its paradigms provide us with unities of thought, but these are tentative and are modified or supplanted; they are also often uncertain--as in the uncertainties in mental hygiene over organic or sociological causes for mental illness. Its advances pave the way for the vast technological changes that upset institutional organization and legitimacy.

Second, understanding of the paradigms of science and of the necessities for its existence is not as easy to achieve as is the understanding of technology. The benefits of the latter are evident and its advances come to be familiar to every school boy. But science is more esoteric, its benefits are indeterminate and remote, and therefore understanding of its relevance to our present choices is limited.

Finally, scientific method and the paradigms of science do not comprehend for us all the wisdom that is necessary for human choices on social action. Recently Don K. Price, in his presidential address at the American Association for the Advancement of Science, saw a role for science in social policy: ". . . to help clarify our public values, define our policy options, and assist responsible political leaders in the guidance and control of the powerful forces which have been let loose on this troubled planet."2/ But Price used the words "help," "define," and "assist," and did not suggest that science could substitute for political decision on the issues created by technology and science.

Ultimately, much of society's response to technology and science must be made through political decision. Where the institutions and processes for such decision have been stabilized over time and legitimized by general acceptance, as in the United States, their very existence provides coherence and stability to the social fabric. They provide us with standing arrangements for response to technological and scientific change. Yet these, too, may have to change in order to serve as viable instruments of response. And the capabilities of politics for response to radical change in an established type of system may themselves be limited. One of the apparent effects of technology and science in rapid development is to specialize the professional activities of men, to divide them in groups with attachments to different institutions, and to shatter traditional standards of judgment in the face of new compulsions for decision. This creates pluralism in the society, and

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2/ Don K. Price, "Purists and Politicians." Presidential address delivered to the American Association for the Advancement of Science meeting, Dallas, Texas, December 28, 1968. Published in Science, CLXIII (January 3, 1969), 25-31.

it is the nature of political decision that it is made in response to the varieties of influence that can be brought to bear through the political system. Yet the ideal of democracy assumes that the demands of all men, and particularly those that are important for general benefit, be given consideration in decisions relating to all. It may be, also, that the processes of political decision provide, in the main, responses to immediacies, concessions to existing power aggregations, and incremental adaptations to change. Yet the satisfaction of human aspirations, and the avoidance of threats that are feared, may depend upon more radical innovations in policy and innovations that give effect to purposes that transcend immediate objectives In sum, politics that does not include common goals and that is unguided by visions of future benefits may be immobile or rudderless under the challenge of technological capability and scientific promise.

We must, therefore, look at the nature of politics generated by technological and scientific change and the information our political science knowledge provides us on what we can expect from the political system.

The Political Consequences

The new world of science and technology--characterized by institutionalization and mutual dependence of government and recipient institutions--has generated its own politics. Science and technology are claimants on government. These are represented by supplicant institutions and individuals before government agencies that themselves are supplicants before the Bureau of the Budget, the President, and Congress. Scientists and technologists--as utility and street contractors in cities, and rivers and harbors contractors in Washington, before them--must now seek government's beneficence.

It already has been noted that it would be false to think of this new political force as monolithic. While we can speak loosely and generally about a scientific community, this community is divided into many disciplines, institutions seeking support and prestige, and individuals with those same ends. Technological development is centered in industrial enterprises that vigorously compete for government contracts and in governmental organizations that also must contend for support for their separate programs.

But while the world of science and technology is pluralistic, its forces are partially integrated through institutions with resources and power that can be used for their own sustenance and representation of the interests of their constituencies. Science has the American Association for the Advancement of Science, the National Science Foundation, and the National Institutes of Health, and technology has various professional associations, the Atomic Energy Commission, the National Aeronautics and Space Administration, and the Department of Defense. Although these are centers of flux and competition, they are also points for aggregation. They can win support on occasion from other administrative organizations, such as those interested in weather, communications, health, and education. So while the politics of science and technology is, on the one hand, competitive, it may be, on the other, a politics of potency because of the potentialities for integration through government institutions--giants in themselves and capable of collaboration with each other and with those outside government who share their perspectives and interests.

The expansion of claimant politics is, then, one political consequence of the phenomenal rise of science and technology. There is another political consequence that arises out of their impact on the community. New political issues on the use of scientific knowledge and technological capability are generated. These are the issues of social utilitarianism--the "payoffs" in human benefit that may be sought from science and technology.

Sometimes the advance in science and technology almost automatically provides a payoff in human benefit. When, for example, the Salk vaccine for polio was discovered, simple and easy arrangements for its universal use, generating no public controversy, quickly eliminated a dread killer. But in other instances, the problems, the issues, and the potentialities for universal benefit are in varying degrees more complex, baffling, and involved in political controversy. Weather control and space communications seem to present only simple problems of organization of administrative systems for public service, but these get involved in political conflict.3/ Air pollution, the result of ill-considered use of technology, creates more difficult problems of conflict between community interest and business concerns. Biological science and medical technology generate a multitude of problems and highly divisive politics over whether and by what means the benefits of knowledge and capability shall be made available to some or all. Agricultural science and technology, promoted by government for a century, now present it with baffling issues on production and use. Pesticides present benefits to be used and dangers to be avoided, and the latter create problems for government. Nuclear energy, missiles, and other weapons of warfare expand so many issues of domestic and international politics as to baffle even the most competent and optimistic policy-makers.

Not least, then, among the effects of science and technology is the flooding of the political system with problems and issues of social utilitarianism. The political system is offered opportunities to collectivize the benefits of science and technology. New policies and institutional arrangements may diffuse the benefits to the community generally. On the other hand, the political system may be overloaded with issues so heavy in number, complexity, and intractability, that it is difficult, if not impossible, to set up means for adequate consideration of solutions in terms of human purpose.

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For the story of how politics has influenced weather control programs, see the forthcoming Inter-University Case Program study by W. Henry Lambright, Weather Modification: The Politics of an Emergent Technology.

A special aspect of the claimant and social-utilitarian politics generated by science and technology is the extent to which technology and science as such should be subsidized for promotion of the public interest. The utilitarian benefits of technological and scientific advance may be remote and indeterminate. Shall these be promoted, nevertheless, because of the possibility of payoffs in human benefit that cannot now be defined or even anticipated? Is technological capability so fertile a source of human progress that capability itself should be promoted avidly with expectation that any outburst of development will produce new potentials for human life? In the case of science, the issue is even broader. Shall science be promoted for the sake of understanding to satisfy man's desire to know the nature of the universe and of the human species? These questions, particularly those related to science, are often referred to in discussions of space objectives as "Columbus-type" issues. In space politics it is suggested that man gamble on payoffs, or that he expand his search into the unknown because this too is part of human purpose--for some men the highest of their aspirations. These questions get involved in the politics of resource allocation as budgets are considered. Their intangibleness may weaken their political force, but certainly they expand the issues and magnify the complexity of political decision.

The important question raised by this politics of technology and science is one that should be the central inquiry of political science in our day: Can the political system have the capability of handling the multiple and complex issues toward fulfillment of human purpose? A clue for success of a political system that often appears in learned discussions was stated quite simply by John Stuart Mill, famous student of representative government, prior to the accelerated pace of technological change. He stated that "one of the important ends of political institutions . . . /is/ to secure, as far as they can be made compatible, the great advantage of the conduct of affairs by skilled persons, bred to it as an intellectual profession, along with that of a general control vested in, and seriously exercised by, bodies representative of the entire people."4/ Mill was talking only about the "conduct of affairs" by bureaucracies and about a single category of "skilled persons." He did not foresee the multiple specializations of science and technology, and the institutional integrations of these specializations in interrelated private and public organizations, so that the bureaucracies themselves reflected specializations in perspective, loyalty, and interest. Yet if we amend his category of "skilled persons" to include all the specialized talents and institutions that now exist, we can see that he stated the problem of representative government: its confrontation with the capabilities offered by the organization of knowledge and skills.

Of even more significance is the fact that Mill did not foresee the multiple problems in representation of the "entire people" in a technological

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4/ John Stuart Mill, On Representative Government, Chapter VI.

age. He did not foresee the scope and force of claimant politics and the potential identifications by those engaged in it of their personal, professional, and institutional perspectives with the "general welfare." He did not foresee that these specialized perspectives could be pushed upward into the structure of government in such ways and to such an extent that the independence and capability of the controls on behalf of the "entire people" could be threatened. Nor did he foresee that interpretations of the public interest might be amorphous or even non-existent, nor even that the concepts of the "entire people" and the "public interest" could be denied.

The problem of the identification of the "bodies representative" with the "entire people" in consideration of the multiple and complex issues of a technological age is a perplexing one. On the one hand, technology and organization have enhanced the opportunities for maintaining links between "bodies representative" and the "people." Transportation and communication have made it possible to take the ballot of the people in national elections in the United States, an idea that in the language of a member of the constitutional convention of 1787 appeared, even for the 13 states then existing, "chimerical." They make it possible to learn the attitude structure of the public through opinion polls. It is now even possible to have nationally televised debates on specific issues and poll the listeners thereafter. Education and communication, while they cannot equip the citizen for weighing all the factors that enter into a decision, have produced literacy on science and technology and the policy issues they present among a large segment of the public. Intermediary structures of various types--our numerous associations of persons with shared group interests--provide opportunities for access to our representatives. There are opportunities also for personal communication with representatives, and for mass demonstration.

Yet on the other hand, in the consideration of policy issues there can be a considerable gap between the "bodies representative" and the "entire people." Many of the latter are unconcerned. Those that are concerned cannot know or give attention to all the issues that affect them. The business of government is delegated. Moreover, it requires on any given policy issue attention to numerous technicalities and complexities, and procedures to reduce the imponderables and enlarge the grasp of feasibilities.

Representation of the people will depend, first, on knowledge of what people want, and for this some national discussion and debate to raise issues to public visibility and engage public concern appear to be necessary. Not all of us need to be--nor can be--participants in the discussion on any issue, but men will feel frustrated and alienated and they will be conscious of inattention to their wants if they do not feel that the scope of the discussion encompasses their goals.

Representation of the people depends also on something more intrinsic to the complexities of the decision-making situation--on the ways the issues are presented and the processes of their consideration. What will be reflected in the issues and alternatives that are pushed up for consideration: the interests and perspectives resulting from specialization, broader identifications of interdependent interests and common purpose, or some meshing of these? Will there be incremental buildups in policy for claimant groups and social utilitarianism, innovations offering new responses to change, or some combination of these two? How carefully will the alternatives be traced out and weighed, and with what balances between internal bargaining of interests and vision of public goals to be achieved? Representation of the "entire people" will require, in our opinion, some focusing on interdependent and common interests, some innovation, and some weighing of decisions in terms of public goals.

Interpretations of the American Political System

We are led inevitably by this discussion to the hard question of political reality: How can we expect the political system to operate in response to multiple issues in a technological society? Social scientists in the United States--particularly political scientists, since they deal with questions of power--have supplied us with a considerable body of ideas that are relevant to the answer to this question. We desire in this book to see whether some of the standard but varied and often conflicting interpretations of the American political system, as it operates now or may be expected to operate in the future, are supported by the substantive results and processes of decision on manned space flight. We must, therefore, present these interpretations in the two categories into which they generally fall: nondemocratic and democratic.

Nondemocratic Interpretations

There are three distinct arguments today that power is concentrated in the hands of either one small group of persons or in several small groups that cannot be assumed to be representative of the community, at least as the result of participation by or on behalf of persons in that community. The first of these challenges may be called technocratic oligarchy. According to this idea the power to govern will be in the hands of a technostructure that is not forced by community participation to act on behalf of the community. This argument holds that the balance between the experts and the controls on behalf of the community, about which we wrote in the preceding section, will not be maintained.

There is in the literature a diversity of opinion about what the technostructure is or whether it is in a position to govern. James Burnham, a student of management, argued in 1941 that we would be governed in the society of the future by a managerial class.5/ Victor Thompson, however, has argued that power is passing to the technical specialists because managers lack ability to direct and supervise them.6/ President Eisenhower, in his farewell address, was worried, not about administrators, but of the "danger that public policy could itself become the captive of a scientific-technological elite." John Kenneth Galbraith, who coined the word "technostructure" in 1967, thought that the business organizations of the country were governed by such a technostructure. He defined it differently from Burnham, saying: "It embraces all who bring specialized knowledge, talent or experience to group decision-making. This, not the management, is the guiding intelligence--the brain--of the enterprise."7/

This leaves room for exploration of technocratic government as pluralistic rather than concentrated. There may be internal pluralism in the management of corporations--in fact, as some authors have argued, they may be governed through the mediation of differences within and among them.8/ Galbraith also had argued earlier that the power structures of particular corporations might be "countervailed" by the power structures of other organizations (corporations, unions, government).9/ Don Price looked at the political system and concluded that countervailing forces operated within it to prevent government by a technocracy. He found that power was shared among four estates within government--the scientists, the professionals (lawyers, engineers, physicians, etc.), the administrators, and the politicians.10/ Redford

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5/ James Burnham, The Managerial Revolution: What is Happening in the World (New York: John Day Company, Inc., 1941).

6/ Victor A. Thompson, Modern Organization: A General Theory (New York: Alfred A. Knopf, Inc., 1961).

7/ John Kenneth Galbraith, The New Industrial State (Boston: Houghton Mifflin Company, 1967), p. 71.

8/ See James March, "The Business Firm as a Political Coalition," The Journal of Politics, XXIV (November 1962), 672-78; Chester I. Barnard, "Elementary Conditions of Business Morals," California Management Review, I (Fall 1958), 1-13; and Emmette S. Redford, "Business as Government," in Public Administration and Democracy: Essays in Honor of Paul H. Appleby, ed. Roscoe C. Martin (Syracuse, N.Y.: Syracuse University Press, 1965), Chap. IV.

9/ John Kenneth Galbraith, American Capitalism: The Concept of Countervailing Power (Boston: Houghton Mifflin Company, 1952).

10/ Don K. Price, The Scientific Estate (Cambridge, Mass.: Harvard University Press, 1965).

has argued that the sharing was even wider, including four other estates--the power brokers outside government (party leaders and group leaders), the opinion makers, lay participants in government, and the eighth estate composed of all who do not participate regularly in decisions in particular areas but who have means of making their interests felt (through voting, demonstrations, civil disobedience, etc.).11/

We are left by the various facets of this discussion with some important questions. First, whose interests will be served by the technostructure? Will it, because of both the limited perspectives and personal stakes of its members and the parochial interests of organizations within which they serve, represent a lesser diversity of interests than exists in the public as a whole? Or will it be compelled to represent, to some extent, the wide range of human purposes because of the professional habits and loyalties of its members, their sharing of the ideals of the society in which they live, and the supplementation of each group of technical experts by the endeavors of others? Are these internal safeguards against a technostructure enough? Can the full range of interests in the community be represented without strong overhead political direction? And can such direction be organized so that it can be brought to bear effectively on the technostructure?

Second, while we must depend upon the technostructure for technical analysis and for knowledge of what is feasible, can we depend upon it to give us the innovation that is needed for continued technological advance and social use of technology? Will the technostructure, institutionally organized as it is, operate incrementally within the patterns of the past? Can it be expected to have social perspectives on the uses of science and technology? Will it, because of its institutional connections, require external stimulus and guidance on purpose if it is to give technical support for innovative uses of science and technology?

The second challenge to democracy may be called functional oligarchy. This is the idea that the power to govern has devolved upon distinct aggregations of persons, each able to dominate the decision-making process in a particular area of public policy. It argues that control over government has been lost by the President, Congress, the parties, and the community to those who give their continuing attention to policy in particular areas. Government is, in this view, only a

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11/ Emmette S. Redford, Democracy in the Administrative State (New York: Oxford University Press, 1969), pp. 56-69.

loose federation of subsystems, each operating with large autonomy from the macropolitical system.

The existence of subsystems is attested in contemporary literature. Leiper Freeman defines a subsystem as "the pattern of interactions of participants, or actors, involved in making decisions in a special area of public policy." He describes one type of subsystem--the type that concerns us in this study--as that created by the interaction of executive bureaus, congressional committees, and intimately-associated interest groups.12/ Douglass Cater saw "subgovernments" composed of the interaction of these three groups in "one important area of policy after another." His examples included "the tight little subgovernment which rules the nation's sugar economy" and the "loosely knit power system" that formed the "subgovernment of defense" (what President Eisenhower called the "military-industrial complex").13/ Another author, studying the regulation of civil aviation, found that persons occupying "strategic positions" in administrative agencies, related congressional committees, and interested private organizations were centers through which influence could be exerted on public decisions.14/

This is not the same challenge to democracy as that of a technostructure. Cater says the subgovernments comprise "the expert, the interested, and the engaged."15/ The technostructure is only a part of the subgovernment. Yet the issues with respect to democracy are similar to those stated in concluding the discussion of the technocratic challenge. Can the subgovernments within themselves give representation to the total complex of interests in the society? Or alternatively, can the macropolitical system--the President, Congress, parties, and the public influences on these--direct and control subgovernments on behalf of the community?

12/ J. Leiper Freeman, The Political Process: Executive Bureau-Legislative Committee Relations (2nd ed.; New York: Random House, 1965), p. 11.

13/ Douglass Cater, Power in Washington (New York: Random House, 1964), Chap. I and II, with quotations from pp. 17 and 21.

14/ Emmette S. Redford, "A Case Analysis of Congressional Activity: Civil Aviation, 1957-58," The Journal of Politics, XXII (May 1960), 228-58, reprinted in Redford, The Regulatory Process: Illustrations from Civil Aviation (Austin, Texas.: University of Texas Press, 1969), Chap. III.

15/ Cater, p. 17.

The third challenge to the democratic interpretation is economic-social elitism. The thesis is that there will be one power elite in the community (local or national) with roots in the economic and social system that controls decisions in government. According to this view, neither a technostructure nor a subgovernment would possess power to govern as an independent and autonomous force, for either would reflect the interests of the economic and social elite.

The chief sources of argument for this position are two sociologists, C. Wright Mills and Floyd Hunter. Mills in 1956 published The Power Elite, in which he argued that an "inner circle of 'the upper social classes'" form a power elite that determine the course of national events, insofar as these are decided by men. This elite is an economic and military elite with dependent appointed officials and politicians.[16/] Hunter in Community Power Structure in 1953 reported on a study of a single large city, in which he showed the influence of an economic-social elite.[17/] These studies have been followed by others that offer additional empirical evidence to substantiate the thesis, or hypothesis, of elite control. Most of these studies examine the location of power in cities of relatively small size. Those that treat national politics present the strongest evidence of elite control for the two areas of international and military policy-making. The argument has not been fully developed for such areas as educational, welfare, conservation, labor, and business policy.

There is much argument over what is proven and not proven by these elite studies. While the many issues concerned with the data and conclusions cannot be examined here, some comments will be relevant. The first relate to the nature and significance of the counter-challenge to the social-economic-elitist interpretation by Robert Dahl.[18/] Dahl found in a study of New Haven that in three separate areas of political action, there was little overlapping in the groups that exercised control. Some political scientists have interpreted this as evidence of the pluralism (and nonelitism) of the American political

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16/ C. Wright Mills, The Power Elite (New York: Oxford University Press, 1956).

17/ Floyd Hunter, Community Power Structure (Chapel Hill, N.C.: University of North Carolina Press, 1953).

18/ Robert A. Dahl, Who Governs? Democracy and Power in an American City (New Haven, Conn.: Yale University Press, 1961).

system. As one commentator said, "To some extent, where the sociologists found monopoly and called it elitism, political scientists found oligopoly but defined it in more honorific terms as pluralism."19/ But oligopolistic pluralism would not necessarily be democratic pluralism. If power is exercised by separate groups of persons in each area of public policy, then we have political subsystems, or differently stated, subgovernments. Subgovernments can exist in a local as well as a national setting. But these subgovernments would not be democratic if they were autonomous and did not within themselves represent the full pluralism of the community. They might create multiple, or functional, oligarchies rather than a monopolistic elitism.

Second, there may be a vast difference between the political systems of communities and of the nation. Robert Presthus has said that "the size factor is critical in determining the structure of community power. If we assume that a pluralistic leadership structure requires a fairly large reservoir of individuals with leadership skills, it may well be that smaller communities just do not possess enough potential leaders to make possible a lively competition among organized groups."20/ On the other hand, it may be that the very size and complexity of our national political system make impossible any dominance of the system by a single power elite, however much they might attempt it. The action of such an elite may be only a wave, albeit perhaps a large one, in an ocean of influences on policy. Functional elitism--that is, the existence of different elites for different areas of policy--operating through subgovernments might be expected more reasonably in the national political system than monopolistic elitism.

One aspect of the charge of elitism at the national level as this critique was framed by Mills is rather plausible and does bear serious note. Mills argued that the elite would come to operate through wholly implicit coordination--as price-fixing schemes in industry have been known to do. This coordination could come about through common social backgrounds giving decision-makers common perspectives. More important, such perspectives could be produced by socialization within major institutions in that they all do possess similar structures, and criteria for selection to the top levels tend to be consistent. This type of elitism, to the extent that Mills' description is accurate, is dangerous because it is obscure.

19/ From Robert Presthus, Men at the Top: A Study in Community Power (New York: Oxford University Press, 1964), p. 430.

20/ Ibid., p. 45.

We now have seen three kinds of challenges to democracy: the challenge of monopolistic elitism--the elitism of an upper economic-social class; the oligopolistic challenge--the functional oligarchies of leaders in subgovernments; the challenge of technocratic oligarchy--that of a technostructure, operating as the controlling element in each of the subgovernments.

Democratic Interpretations

Democracy is, both inherently and because of the great variety of explanations of it, difficult to explicate as a basis for interpreting the operation of a political system. We are aided, nevertheless, by the fact that democratic interpretations make use of three concepts. One is that of majority rule. The technical difficulties of arranging for majority decisions on policy issues, and the ethical issues about unlimited majority rule, militate against unqualified acceptance of it as a complete guide for government;[21] yet all democrats probably would recognize the necessity for some majority judgments, both by voters and by their representatives.

The second concept is consensus. While most persons would believe that full consensus is never attained--and that policy choices usually represent some blend of consensus, compromise, and choice--they may still believe that policy cannot prevail unless there is considerable consensus for the main lines of policy over time, and a strong consensus in favor of the processes ("rules of the game") by which decisions are made. They may believe also that consensus is built on common interests and that the main task of the policy-maker is to discern widely-shared interests and find ways of representing these in policy.

The third concept is pluralism. This is a fundamentally important conception in the interpretation of American government because it is taken widely among political scientists to be an effective concept, both for description and prescription. Basically, the concept is composed of the following ideas: Men in society have a variety of needs, values, and stakes, some of which are shared or "overlap" with those of other men. Because political demands based on these are not shared equally or at all by all men, the argument goes, public policy will be made by mediation (compromise, adjustment, bargaining are other words commonly used for the process) among contending groups. The mediation will be achieved through associations and institutions before and in which these groups are clustered and represented. One purported

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21/ See Robert A. Dahl, A Preface to Democratic Theory (Chicago: University of Chicago Press, 1956), pp. 38-44.

advantage of this pattern is that such groups provide countervailing power to government, and indeed that the mutual adjustment may be shared between public and private sectors and in the two as part of one social process. The policy process, in this interpretation, is primarily one of mutual adjustment, rather than of choice or consensus. Moreover, questions of basic principle are avoided and decisions are focused on increments to existing policy. In philosophical terms this structure operates in terms of an ethic of process rather than an ethic of ultimate principle or substance. The process is the focus of political consensus, and the outcomes of the process are hence "right."

The pluralist may accept the idea that democratic government cannot be viable without a substantial base of consensus on policy objectives, and also the necessity of majority decision at certain times and within some forums. He may argue, however, that both are reflections of pluralism in its broadest sense, consensus arising from a broad sharing of some of the multiple interests, and majorities themselves being formed by coalitions of diverse interests.

The pluralist interpretation of democracy, while widely prevalent among political scientists, nevertheless has been under attack from within their ranks. Basically, the charges advanced oppose it as a prescription for democratic government, although they also include questions on its empirical validity as a comprehensive and sufficient analysis of the operation of the American political system. One charge is that the pluralist interpretation is, after all, elitist. The charge is that the associational and institutional clusters in which group representation is focused have no real and vital connection with the people they are presumed to represent. This denies a key ethical premise of democratic theory that citizenship requires representation in decisional structures. The critics point out that some pluralists have judged that a large degree of political apathy in a political system is good--a sign of health in that tensions are low and the decision process is working successfully. Another charge of "pluralistic elitism" is that the policy clusters are not truly representative of all the interests and stakes affected by the policy they make--that they are biased toward upper classes and toward those technostructures and specialist groups that are in Cater's words, "the expert, the interested, and the engaged."

A further charge is that the pluralistic prescription for democracy accepts a sublimation of politics in that policy issues are framed in such a way as to prevent truly meaningful political issues from being raised. One element in this attack is that while a system of pluralistic democracy might handle small decisions on increments in policy satisfactorily to the group participants, and thus continuously mediate the tensions raised to the surface, it loses its capacity to cope with major questions of policy and to innovate in response to new capabilities in a world of rapid technological and scientific change. We can take little comfort in our international politics if major decisions on today's conflicts between powers successfully mediate disputes but the basic problems of a long-run structure for peace are unattended; or if in our domestic politics today's explosions of violence are moderated but the capabilities for use of technological production for general human benefit are unexploited. Another element of the attack is that a governmental system operating on the pluralist model might fail to articulate the latent and unorganized but widely-shared interests whose satisfaction might be possible through maximum use of society's technology and science. The result might be a kind of political vacuum between the promises of political leadership, attuned to the aspirations of men, and the ability of political leadership, under the limitations of issue formation in pluralistic structures, to respond to these aspirations with effective program development. Finally, the pluralistic system, it may be charged, militates against exploitation by political leadership of the opportunities for consensus toward innovation in public policy. The pluralist assumes a consensus in favor of the processes of American democracy (if the appellation is appropriate). Indeed, recent events indicate he may have overassumed. But consensus on process may not be enough. For policy consensus on new issues, ideological foundations, exploited by political leadership, may be a factor in viable democracy toward use of technological capability.

This summary of attacks on pluralism as a prescriptive tool reflects our own views on what is most meaningful in current attacks, and what is most relevant to a discussion of social utilization of technological capacity and scientific knowledge. We turn now to an interpretation by a political scientist who sees inadequacy in either the elitist or pluralist interpretations as comprehensive descriptions of realities in the American political system.

A Comprehensive Interpretation

Recently Theodore J. Lowi has questioned single interpretations of the operation of the American political system.22/ He thinks "that for every type of policy there is likely to be a distinctive type of political relationship." Although his classification scheme may not exhaust "all the possibilities even among domestic policies," he thinks that "three major categories of public policies" can be dis-

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Theodore J. Lowi, "American Business, Public Policy Case-Studies, and Political Theory," World Politics, XVI (July 1964), 673-715.

tinguished. He calls these "distributive," "regulatory," and "redistributive." And he believes that politics works differently in each of these. There are

> certain kinds of government decisions /that/ can be made without regard to limited resources. Policies of this kind are called "distributive," a term first coined for nineteenth-century land policies, but easily extended to include most contemporary public land and resource policies; rivers and harbors (pork barrel) programs; defense procurement and R&D; labor, business, and agricultural "clientele" services; and the traditional tariff. Distributive policies are characterized by the ease with which they can be disaggregated and dispensed unit by small unit, each unit more or less in isolation from other units and from any general rule. "Patronage" in the fullest use of the word can be taken as a synonym for "distributive." These are policies that are virtually not policies at all but are highly individualized decisions that only by accumulation can be called a policy. They are policies in which the indulged and the deprived, the loser and the recipient, need never come into direct confrontation. Indeed, in many instances of distributive policy, the deprived cannot as a class be identified, because the most influential among them can be accommodated by further disaggregation of the stakes.23/

We have quoted this statement at length, both for clarity and because R&D was included in the category. Lowi thinks that, as E. E. Schattschneider stated his conclusion on tariff policies, there is in this type of policies "'mutual non-interference' among uncommon interests."24/ In this situation, according to Lowi, there are elements of both pluralistic politics and elitist politics; but the former was characterized more by mutual noninterference than by the conflict of groups assumed in pluralistic theory, and the elitism was centered in the congressional committees with jurisdiction in the policy areas.25/

23/ Ibid., pp. 688-91.

24/ E. E. Schattschneider, Politics, Pressures and the Tariff (New York: Prentice Hall, 1935).

25/ Lowi, pp. 680, 693.

"Regulatory policies" are distinctive in that they involve "a direct choice as to who will be indulged and who deprived."26/ Regulatory policies affect sectors of the economy and typically involve conflict and compromise among "a multiplicity of groups organized around tangential relations."27/ In this sense, the pluralist explanation of policy-making can be accepted generally. "Redistributive policies," such as the income tax and welfare policies, tend to involve "social classes"--"crudely speaking, haves and have-nots, bigness and smallness, bourgeoisie and proletariat."28/ "Issues that involve redistribution cut closer than any others along class lines and activate interests in what are roughly class terms."29/

We are led to the question of whether the politics of space, and of R&D in general fits into one of Lowi's categories. To the extent that space politics is claimant politics it apparently may fit into either the distributive, regulative, or redistributive pattern. When the claimants--scientists asking for grants or for their experiments to be carried on flights, contractors seeking contracts, public administrative units seeking funds--can have their claims considered, in Lowi's words, "more or less in isolation from other units and from any general rule," or as Schattschneider said, with "'mutual non-interference' among uncommon interests," then the activities fall neatly into the category of distributive politics. When they come into confrontation with other claims so that, again in Lowi's words, there is "a direct choice as to who will be indulged and who deprived," the activities fall into the regulatory category. When, however, the claims affect the total amount of the tax bill of the nation, redistributive politics may be engaged at least tangentially.

Yet the sufficiency of these categories may be questioned for the kinds of questions that are raised, or might be raised meaningfully, on social utilitarian issues and issues on which benefits are indeterminate. There is, first, the question as to whether there can be a politics of allocation of resources that in part transcends Lowi's categories. These all, in a way, reflect pluralistic approaches to the explanation of politics, in that they all assume a politics of division --either among isolated claimants, or groups, or classes. The question

26/ *Ibid.*, pp. 690-91.

27/ *Ibid.*, p. 695.

28/ *Ibid.*, p. 691.

29/ *Ibid.*, p. 707.

is presented, therefore, as to whether it is possible to have a politics that to some extent overrides pluralistic politics--whether it is possible to have a politics that centers on community goals, a politics of social utilitarianism, a politics of national debate on issues of relevance to the public at large, a politics in which political leadership focuses attention on elements of national consensus based on accepted interpretations of national purpose.

For this kind of politics there are apparently two conditions. One is that policy alternatives dealt with by political decision-makers be framed in a fashion both comprehensible and manipulatable by the informed citizens who are not actively engaged in the divisional politics that is described in Lowi's categories. Meeting this condition requires that policy be framed in concrete terms so that it can be understood, and that policy offer relatively unambiguous effects so that payoffs and costs are clear and can be manipulated into the individual's own utility framework. The second condition is that means exist for bringing into policy consideration the citizen's stakes in community goals that may be overlooked or subverted in the definitions of policy alternatives and pressures that arise from the institutional activities of regularly engaged interest claimants.

The second question on the sufficiency of Lowi's categories is whether technology now is creating a new type of political issue and hence a need for a new kind of political capability. All the types of politics described by Lowi--indeed, politics as described by most writers--are characterized by one trait: the issues framed under them are issues arising from framing policy and spending money as a reaction to perceived problems. Also, divisional politics of contending interests might be lessened, confined and submerged if programs and processes representing the claims of interest aggregations could be satisfied incrementally. One could imagine, however, that past a certain point in the development either of a society or of a specific policy area, the question of reaction to problems and confirmation of policy and process might not be as appropriate as a more positive and innovative framing of the issues. The conditions bringing this point about would be such things as widespread affluence to the extent that scarcity did not govern decisions, and/or the development of public needs to the point that the basic problems are not solved by ongoing programs and processes.

It may be that technology has created conditions both in society and within the political system that call imperatively for a different approach than normally is described. This approach would be based on the concept of defining positive goals and specifying actions that will achieve these. Such a politics would not be distributive, nor regulatory, nor redistributive. Rather, it might be termed in conventional terms a politics of social planning, or alternatively a politics of social allocation, where resources are spent in accord with a future vision rather than a current response.

Lowi's classification points to a possibility of analyzing policy-making processes in separate areas of policy-making. We suggest, on the basis of distinctions already implied in the previous discussion, the need for attention also to politics at different levels in a political system. There is intra-institutional politics--the politics involved in reaching an institutional position. There is in the literature on organizations an argument or suggestion that innovation may not be characteristic of organizations since these are engrossed in management and development of existing systems and, as custodians of these systems, have stakes in their preservation.[30/] We suggest an hypothesis: that politics in government agencies tends towards incrementalism, protectionism, and stability. There is, second, sub-system politics. This is the politics exerted through all the institutions that are regularly engaged in decision-making for a particular area of policy, such as national defense, regulation of communications, or education. In this politics additional interests are engaged, and it may be expected, therefore, that tensions will be created greater than those in intra-institutional politics. Yet we may hypothesize that it too will tend toward incrementalism, stability, and protection of existing balances of interest. There is, finally, macropolitics, defined as the politics "produced when the community as a whole and the leaders of the government as a whole are brought into the discussion and determination of policy."[31/] Examples are revealed in legislation on civil rights acts, medicine, and federal aid to elementary and secondary education. The President, the congressional leadership, the parties, the press, and the leaders of community discussion may all be involved in this politics. We may hypothesize that interests not regularly represented in a particular subsystem will be reflected in macropolitics, and that the greater diversity of interests represented will produce threats to the incrementalism, stability, and protectionism of administrative institutions and subsystems. Yet the issues presented by the development of modern science and technology may be greater than the macropolitical institutions can absorb. The ability of these institutions to produce policies that are viable toward development and use of science and technology on behalf of the people may be limited, and this possibility is of concern to us in this study.

30/ See, for example, Victor A. Thompson, Bureaucracy and Innovation (University, Ala.: University of Alabama Press, 1969).

31/ Redford, Democracy in the Administrative State, p. 83.

Thus, Mill's problem of the confrontation of representative government with specialized knowledge and skill haunts us as the capabilities of this knowledge and skill for benefit or curse, use or nonuse, are enlarged. The most widely discussed explanations, whether elitist or pluralist, based as they are on assumptions of division of interest, pragmatic response to problems, and incremental advance in policy and process, evade, in their prescriptive aspect, essentials for a viable politics of social utilitarianism. We are interested in this book in seeing whether in one area of policy at a given time the explanations fit the realities, and whether also the decision system reflects the additional, and evaded, elements of a politics of vision toward social goals.

Man in Space After a Lunar Landing as a Case for the Analysis

There are several aspects of the post-Apollo manned space program that make it an excellent case in which to examine the types of questions about the political system described above. First, there is an opportunity here to study decisions-in-the-making, for basic policy is still being debated. Second, while the lunar-landing program was initiated and went through its major growth as a reaction to a specific problem or threat, in the early stage of the post-Apollo period (that which is studied here), this is not true. Rather the policy question faced in this period was, simply, the positive one of "what goals should we pursue in space with the capabilities we will have after Apollo, and what further capabilities should we develop, to provide benefits over a long span of time for the community of men?" Basically, the issue was one of short-range allocation of resources toward long-run objectives.

One set of circumstances impairs the purity of the "experimental conditions" afforded by the case. These circumstances were the Vietnam war and the domestic crisis in the cities at home. Because of the accompanying stringency in appropriations, the conditions were not favorable for consideration of benefits to be obtained from long-range programs. Hence, much of the discretion that was involved in the post-Apollo program was removed and to this extent the issue became a conventional one of response to problem--in this case, of how to hold the space capability together while reducing its funding.

Nevertheless, this condition did not hold in the early stages of the case, and it does present throughout an opportunity to study our government attempting to cope with a large and unusual technological capability--one not distinctly different from what might be presented in national defense or atomic energy, or even in such areas as medical or housing capability if the nation were ready to face the issues of maximum utilization. In space the conditions for study are, despite the qualification in the last paragraph, relatively pure. The major policy alternatives for the post-Apollo period were rather unambiguous, even though sometimes unclarified in their presentations, and pure policy choices--assuming the lack of political complications--were possible. Further, there was no overriding imperative, such as an immediate external threat (like Sputnik), that gave impetus to any of the alternatives and forced an easy decision.

Moreover, space technology offers conditions now that will probably soon be typical of government program decisions. The costs involved are so high relative to similar expenditures in the past that traditional benchmarks are not relevant and the payoffs are diverse and uncertain. The Apollo program time schedule caused the technological capability to develop at such a pace that a clear-cut case of one tendency of technology is provided: the capability exceeds the scope of current perspectives in the political system as to how the technology ought to be utilized. The tremendous development of the technology has produced a geographically dispersed industrial capability with a very delicate systemic and political equilibrium. The political forces arising from this system are both subtle and powerful.

Most important, however, the program provides an example of how the various levels of our political system operate in attempting to cope with a large technical decision. All of the levels of politics and the intrinsic policy tendencies of each are brought into play rather elaborately in the case. Hence, the conditions are here for a description of what type or types of politics technology creates. And while conditions are not perfect, there is also provided an opportunity to assess the capability of our national political system in confrontation with the capabilities of technology and science.

The Perspectives and Methods of This Study

Meaningful questions in the confrontation of the political system with science and technology have been presented. We will not provide definitive answers to these several questions. Indeed, we have made no inquiry into whether there are any elements of social-economic elitism in the space program and have not sought to present evidence separately on each of the other issues presented. We are cognizant of the fact that no single study can provide definitive answers to issues of the kind presented. Indeed, multiple studies on different policy subjects, at different times, or in different arenas of policy-making, and studies made from different perspectives, by use of different models, or by different processes, cumulatively may only inform our judgments about what can be expected from the political system as it now operates or may be reconstructed. We do believe that inquiry, in particular studies about the political system, should be related to meaningful issues about its capabilities. We seek in this study to illuminate the operation of the political system through analysis of the development and consideration of one set of issues in one area of policy-making. We will present, in other words, a case study of decision-making.

The case study is the kind of history that is regularly presented in the case studies sponsored by The Inter-University Case Program, as this one is. Such a case study is a history of events over a limited span of time. It concentrates attention on the process of decision-making. It deals "with actions that cumulatively constitute the process whereby change is made, or, conversely, whereby it is avoided or frustrated."32/

Case studies provide clinical evidence on the way the government operates. They have been developed primarily as teaching materials, having as their aim the revelation to the student of the intricacy and complexity of the processes of decision-making and what may be typical or atypical in these processes. They give the student an inside view, an awareness of government as process, and a sense of the interaction that produces decisions.

The cases have been criticized by some for their failure to produce or test generalizations about behavior in governmental institutions. Authors have provided brief introductions and conclusions drawing attention to what is significant in a particular case. But it is said that the cases reveal uniqueness, variety, and fluidity and do not contribute to scientific understanding by testing hypotheses about behavior.33/

It will be informative in this respect to refer to two experiments in the use of cases. Lowi currently is analyzing a large number of cases, including some Inter-University Case Program cases, to test his concepts about the differences of politics in his three categories. Others may find useful such cumulative information from a number of cases. Frederick Mosher carefully selected more than a dozen government

32/ Edwin A. Bock, in "Introduction" to Governmental Reorganizations: Cases and Commentary, ed. Frederick C. Mosher (Indianapolis, Ind.: Bobbs Merrill Co., Inc., 1967).

33/ See particularly Herbert Kaufman, "The Next Step in Case Studies," Public Administration Review, XVIII (Winter 1958), 52-59.

reorganizations and directed the development of a case on each in order to test one hypothesis on the results of government reorganizations. Mosher's results were impressive, but in ways his plan did not anticipate. The cases proved less than he had hoped with respect to his hypothesis. On the other hand, they overshot his mark in providing the basis for a very illuminating analytical commentary on organization.34/

We have varied in a different way the use of the case method for learning about political behavior. We rejected both a mere recitation of the sequence of events and an effort to test an hypothesis or produce a set of generalizations. We decided instead to do two things: first, to determine for ourselves, and explicate for others, perspectives that would be meaningful as background for understanding the implications of a case; and second, to suggest the significance of the experience revealed in the case, to the kinds of questions about democratic government that we have set forth. We shall present a three-phase discussion that includes exposition of factors that may be expected to have influenced political decisions on a manned space program from 1962-1968, then the sequence of events that form the case study itself, and finally comments on the significance of major influences on policy and on the operation of the political system. The three together constitute in modern parlance, our model or analytical framework.

Both for analytical convenience and to emphasize our objectives, we have presented in a simplified and artificial way (leaving out the picture of mutual interactions among all factors in a decisional situation) representations of our purpose in Charts I and II. Chart I shows in an outer circle the kinds of influences--presently to be described--that will affect decision in a particular instance. These forces converge in a decision situation, represented by the inner circle in the diagram. From the decision process within this situation there emerges a decision or a set of decisions, which in this instance is shown by the large arrow as the output in post-Apollo decisions. We are interested in the total process shown on this chart but additionally in such broader implications as are suggested in the preceding discussion. Chart II shows how our discussion will move sequentially from influences on decisions, to the processes of decision, and the implications with respect to the nature and competence of the political system. Two chapters (Chapters II and III) will present the decision-arena and some contextual factors that affected post-Apollo decisions. Thereafter, in Chapters IV, V, and VI the events of government constituting the experience in post-Apollo manned space decisions from 1962 to 1968 will

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34/ Frederick C. Mosher (ed.), Governmental Reorganizations: Cases and Commentary (Indianapolis, Ind.: Bobbs-Merrill Co., Inc., 1967).

CHART I

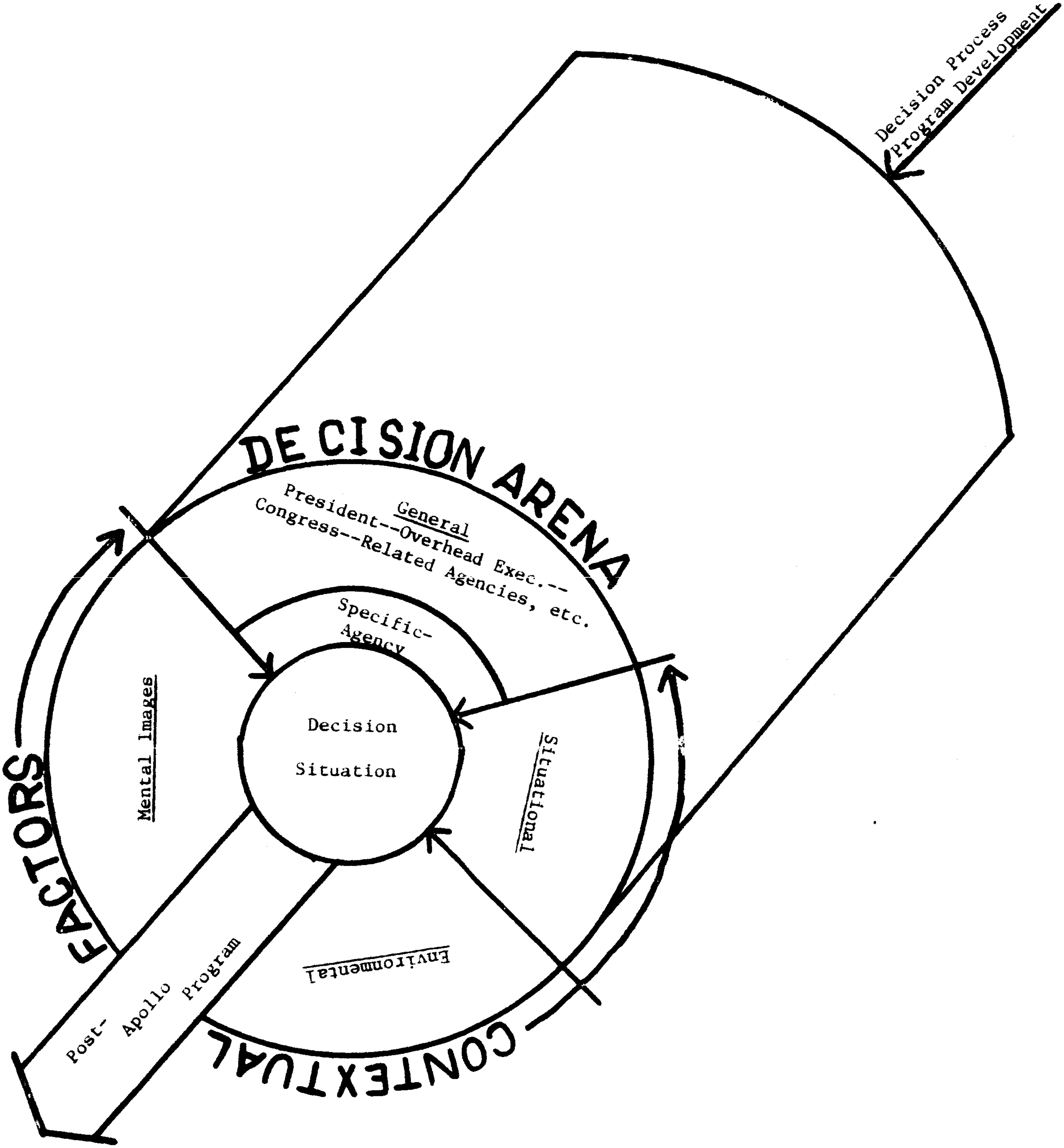
Decision Process
Program Development
DECISION ARENA
General
President--Overhead Exec.--
Congress--Related Agencies, etc.
Specific-
Agency
Decision
Situation
Mental Images
Situational
Environmental
Post-
Apollo
Program
CONTEXTUAL
FACTORS

CHART II

ANALYTICAL PATTERN FOR THIS STUDY

Factors Influencing Policy Decision	Decision Arena Contextual Factors
A Decision in Process	Events of Government in the time frame and on the issues that form a case
Significance in Relation to the Political System	Nature of the Political System 1. Specific: regarding space technology and science 2. General: system as a whole

be set forth chronologically and descriptively. We shall then return in Chapter VII to the basic objective, outlined in the preceding pages, of illuminating the nature of the political system, primarily and specifically as it confronts science and technology, and perhaps also in its total operations.

It remains, therefore, to describe here the kinds of influences that will operate in a particular situation that forms the basis for a case study. We used the terms "decision framework" and "contextual factors" to describe these factors. Decision arena includes both the anatomy and the physiology of decision-making. Structure, or anatomy, includes units within the arena from which role orientations for persons occupying positions will be developed. Procedure, or physiology, includes the interaction patterns and articulation of positions or policies within the structural frame. Decision arena has both general and specific aspects. In its general aspects, its parts include, obviously, (1) the presidency and the overhead political executive system, (2) Congress and its relevant specific components, (3) the agencies for administration of a program or set of programs, (4) administrative agencies with related responsibilities, (5) official advisory-coordinative bodies, (6) clienteles, (7) the public, and (8) the specialized and general communication media. In its specific aspects, it includes such distinctive aspects of the general structure as appertain to the particular functional system for which policy is made.

"Contextual factors" includes three categories of factors, the first two general and the third specific. There are, first, environmental factors, including: (1) the resources that may be available for government programs; (2) the technology and knowledge that may be available--defined to include hardware, skills, explanations, etc.; (3) the time frame within which decisions are made; and (4) the sequence of events prior to the presentation of an issue of policy. The second category, called perceptual factors, is the mental images that influence the way decision-makers will react to problems and issues. These include such ideological predispositions in thought as (1) nationalism, military security, peace, international cooperation; (2) notions about science as a social goal or a standard of judgment; (3) ideas about economic stability, or growth, the maintenance of industrial capacity, and the relation of government to the economy; (4) inclinations for or against societal adventure through public policies; and (5) a variety of ideas about politics--its function and nature, the legitimacy of positive government, the representation of special interests, and the use of resources by government, etc. Third, there will be distinctive situational elements that will have an impact on policy-making. An episode, demands of groups for action, changes in power alignments, a sudden development of new technological capacity, the influence of persons, or other events may create specific impacts on policy development in specific areas.[35/]

In summation, the design for the forthcoming analysis moves through these stages: (1) the elaboration of those factors in the decision arena and of those contextual factors that were especially relevant to development of policy on a manned space flight program after the assumed success of the first manned lunar exploration, (2) the exposition of the events from 1962 to 1968 when the policy issues were considered, and (3) the extrapolation of such conclusions as are possible from one confrontation of the American political system with science and technology.

35/ One of the authors has used a somewhat different, but comparable, listing of influencing factors in another book. See Emmette S. Redford, "Perspectives for the Study of Government Regulation," Midwest Journal of Political Science, VI (February 1962), 1-18, reprinted in his The Regulatory Process: Illustrations from Civil Aviation (Austin, Texas: University of Texas Press, 1969), Chap. I. He distinguished these categories: anatomy, physiology (these two being called here decision space); ecology, which included resources, technology, general (societal) institutional organization, and belief patterns (mental perspectives); and policy history (sequence within a time frame). The contribution of the other author has resulted in the elaboration and refinement of categories for use in this case study.

CHAPTER II

THE DECISION ARENA

We look in this chapter at the structure within which interactions regularly occur, though with variations in continuity and force, in the making of civilian space policy. Space policy may be affected at a particular time from structural centers that with respect to it have occasional or minor influence, but attention is concentrated on the institutional centers and associated groups that have interacted consistently or frequently in post-Apollo manned space decisions, and that have formed therefore the continuing "decision arena" for program decisions on space activity. We shall look also at the processes of program development and policy decision that have been characteristic of this area of government activity. The discussion will be comprehensive of all aspects of decision space, and, near the end of the chapter, will elaborate in increased detail some factors that have had peculiar significance in space policy development. We describe, in sum, the structural and procedural map for civilian manned space decisions, and show interactions that have produced or influenced decisions.[1/] The structural map to be described is shown in Chart III, page 32A.

Congress Sets the Frame

Congress in 1958 mandated a civilian space program, administered by a space agency headed by an Administrator. That agency was given a research and development responsibility, both for aeronautics and outer space. It was delegated responsibility for developing a national capability in space. It would have goals that were exclusively its own, but would also serve goals primarily assigned to other agencies. It would have in this latter respect an R&D function for agencies having responsibilities related to weather, communications, transportation, national defense, and other areas. Its program also would be of great interest to scientists, universities, and corporations having capability for space research and technology. Particularly significant would be its relation to the Department of Defense, which would have its own space program, with operations centered in the Department of the Air Force. In addition, its activity was heavily concentrated by the executive decision, sanctioned by congressional authorization and appropriation, to go for a manned lunar landing within a decade.

1/ The story herein gives the facts as of 1968.

CHART III

DECISION ARENA

Congress

House of Representatives

Committee on Science and
Astronautics
Subcommittees
Committee on Appropriations
Subcommittee on Independent
Offices

Senate

Committee on Aeronautical
and Space Sciences
Committee on Appropriations
Subcommittee on Independent
Offices

Presidency

President

National
Aeronautics
and Space
Council

Bureau
of the
Budget

Office of
Science and
Technology

President's
Science Advisory
Committee

NASA

Department of
Defense

Atomic Energy
Commission

National Science
Foundation

Communications
Satellite
Corporation

Weather Bureau

Other agencies

Agency
Management

Divisions

Centers

Contractors

Science Organizations

Business Organizations

Press

Public

For NASA, the Space Act provided for appointment of an Administrator and Deputy Administrator by the President with the advice and consent of the Senate. In addition to the Bureau of the Budget and the White House staff, the President has had the assistance on space matters of three advisory organizations. The Space Act created the National Aeronautics and Space Council, composed since 1961 of the Vice-President, Secretary of State, Secretary of Defense, Administrator of NASA, and Chairman of the Atomic Energy Commission, and served by an Executive Secretary. There is also in the Executive Office an Office of Science and Technology, established by the President in a reorganization plan in 1962; the director of this office is chairman of the Federal Council for Science and Technology, similarly created in 1959. There is also a President's Science Advisory Committee (PSAC), composed of scientists.

Within Congress, as is true of other programs, there are four primary working centers within which consideration leading to space decisions is concentrated. These are the program committees, called in the Senate the Committee on Aeronautical and Space Sciences and in the House the Committee on Science and Astronautics (referred to here as the Senate or House space committee), and the appropriation subcommittees--in each house the Independent Offices Subcommittee (referred to here as the Senate or House appropriations subcommittee).

Within the periphery described above, in the main created or approved by Congress, there have been two factors in congressional decision that have greatly affected the allocation of roles in decision-making in the civilian space program. The first was the Johnson Amendment to the Space Act, passed within one month after the Space Act and made permanent in 1959. The amendment, enacted under the influence of Senator Lyndon B. Johnson (Dem., Texas) while he was chairman of the Senate space committee, provides that no appropriation can be made to NASA unless "previously authorized by legislation hereafter enacted by the Congress." The amendment has led to annual authorization acts.

Annual authorization of appropriations by special legislation is not traditional or usual procedure in Congress, although limitation of authorization to one year or a few years is becoming more common. It has had two big effects in the space program. First, it has produced recurrent detailed reviews of space administration by several congressional committees, for the space committees, as well as the appropriations subcommittees, annually review the appropriations proposals. This has amplified the opportunities for congressional influences, both positive and negative, on details of administrative programs and projects. Second, the Johnson Amendment, combined with the greater attention that specialized space committees can give in comparison with the appropriations subcommittees, which deal with many agencies, has made the space committees rather than the appropriations subcommittees the main centers for congressional surveillance of space administration and decisions on space policy. Senator Spessard Holland, (Dem., Florida) in comments that appear equally descriptive for the House of Representatives, said to a NASA official in Senate space committee hearings in 1967: "If I may again remind you, I think the Appropriations Committee is going to rely in large part on the record made here. It has heretofore. It does not have the time to go into these matters like this Authorization Committee does. . . ." 2/ The space committees provide the first and the most extended review of appropriations submittals, and the reviews encompass analysis of all major space policy issues. Space policy is considered fully in the annual authorization deliberations of the space committees.

The annual authorization requirements, and appropriation reviews as well, have not affected all NASA programs in the same way or to the same extent. The commitment of the nation to a manned lunar landing within a decade has been firm, and annual authorization for this program has followed as a matter of course, with appropriations made as were deemed necessary. Congress, however, has looked carefully at the program's development during each annual review. On other programs, such as the unmanned programs and the post-Apollo manned space program, NASA has had to battle annually before four committees for concurrent action for specific amounts for specific programs or increments thereof. The requirement of annual submission to four forums has increased the dependency of the agency on Congress and the uncertainties of program continuity.

The other factor in congressional decision that is a major determinant of the allocation of responsibilities for the space program is the structure and specification of appropriations in the authorization and appropriation acts. Congress has allowed the agency much freedom in the use of funds. The appropriations acts have appropriated in lump sums for three categories: Research and Development (R&D), Construction of Facilities (C&F), and Administrative Operations (AO). For the first two of these it always has been specified in the appropriation acts, in accordance with an authorization act provision, that funds would remain available until expended and could be used also to finance procurement authorized in other annual appropriation acts. A more limited authorization to extend for a limited period beyond the fiscal year has been provided in the AO authorization. Second, an up-and-down provision has allowed transfers not to exceed five percent from one of the three categories to another. The additional limitations in the authorization acts also have been accompanied by flexibility. Since 1963 the largest item--in 1968 $3.925 billion of $4.5889 billion appropriated was for R&D--has been broken into line items in the authorization act. Over half

2/ U. S. Senate, Committee on Aeronautical and Space Sciences, NASA Authorization Hearings for Fiscal Year 1968, 90th Cong., 1st Sess., April 18, 1967, Part I, p. 47.

of NASA's authorization has been in one line item, the Apollo program, and thus transferable from one Apollo project to another or even usable for studies or projects that look forward to post-Apollo programs. Also, the agency has been allowed to transfer between R&D line items. This transfer authority has been subject to statutory limitation: funds cannot be used for a program Congress deleted, or for one that has not been presented to Congress, or in excess of amounts appropriated, unless a report has been made to the space committees that may by action of each disallow the change within 30 days. Furthermore, while in early days C&F projects were specified, Congress now appropriates lump sums for C&F to each NASA center (i.e., field centers, such as Langley Research Center of the Manned Spacecraft Center). The significance of this change, however, is diminished by the decline in expenditures in this category--from a high of over $750 million in each of fiscal years 1963 and 1964 to less than $40 million in fiscal year 1968. Finally, the AO item is large and allows flexibility in use of funds appropriated to that category. These and certain relatively minor provisions give the Administrator great flexibility in planning as he develops an operating plan after the appropriation act is passed and as the Bureau of the Budget apportions funds during the fiscal year. He can, for example, (if he assumes the space committees will support him) decide that a portion of funds appropriated for Apollo can be used for post-Apollo programs. On the other hand, committees often make decisions on projects or programs that are parts of a line item in the authorization act. Thus, the Apollo Applications Program was considered separately in each space committee two years before it became a line item in the budget in fiscal year 1968. The Administrator will be careful not to disregard firm and strong opinions in the committees and to inform the space committees of major changes made in his operating plan or at other times, even when this is not legally required. He has in recent years supplied the authorization and appropriation committees with copies of the operating plan and invited their requests for discussion of it; such discussions have been held with the authorization committees. Among the effects of the allocation of discretion and of the concomitant relationships of NASA to the space committees are an increase in the continuity of the surveillance of these committees and further emphasis on their position as the main centers of congressional oversight.

The Agency Organization

NASA's functions are performed through four levels of organization: the agency directorate, or first level of organization; the headquarters divisions, called Offices, forming a second level of organization; the field centers; and contractors. The line of responsibility runs upward from contractors to centers, to headquarters Offices, and then to the top headquarters level.

The Agency Directorate

During much of the period covered in that portion of post-Apollo planning described in this study, the agency was directed at the first level by a triumvirate, sometimes called the troika by agency personnel. The chief in this pre-1966 troika was the Administrator, James E. Webb, who served in this capacity from February 14, 1961, to October 7, 1968.3/ Previously Webb had been attorney, businessman, and public administrator. During the Truman administration he was, successively, Assistant to the Undersecretary of the Treasury, director of the Bureau of the Budget, and Undersecretary of State. Thereafter he was engaged in business, chiefly as an executive in companies manufacturing aircraft and oil equipment and supplies. He was also active in many public service programs related to his interests in science and education. He was recommended for NASA Administrator by Vice-President Johnson, President Kennedy's adviser on space, and endorsed by Senator Robert S. Kerr (Dem., Oklahoma), then the new head of the Senate space committee, with whom Webb had been associated in his capacity as an executive in Kerr-McGee Oil Industries, Inc. His qualifications for the position were affirmed by Jerome Wiesner, science adviser to President Kennedy on space programs. Webb's choice represented a victory for those who believed that "political savvy" was a more important qualification than scientific or engineering experience. President Kennedy told Webb he wanted "someone who understands policy. This program involves great issues of national and international policy."4/

Second member of the pre-1966 troika was Dr. Hugh L. Dryden. A governmental scientist-administrator since 1917, he had been Director of the National Advisory Committee for Aeronautics since 1947, and became Deputy Director of NASA when it took over the functions of NACA in 1958. His career had been entirely in the public service and his interests were summarized in his own words: "The airplane and I grew up together. . . . I have had the good fortune to be associated with the great growth in aviation from that primitive vehicle /which he saw in 1910/ to the jet liners of today and our beginning manned space flights in Mercury and Gemini." Webb obtained a commitment from

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3/ On NASA's administrative structure prior to Webb's appointment, see Robert L. Rosholt, An Administrative History of NASA, 1958-1963 (Washington, D. C.: National Aeronautics and Space Administration, 1966).

4/ For the full story of Webb's appointment, see John M. Logsdon, NASA's Implementation of the Lunar Landing Decision (Washington, D. C.: National Aeronautics and Space Administration, 1969).

President Kennedy that Dryden be continued as Deputy Administrator, and he occupied that position until his death on December 2, 1965.

Youngest man in the troika was Dr. Robert C. Seamans, Jr.--42 years of age in early 1961, as compared with Webb's 54 and Dryden's 62. Educated as an engineer with specialization in aeronautics, he has spent his career in missiles and aeronautics development, first as teacher and project administrator at the Massachusetts Institute of Technology, then in engineering management with Radio Corporation of America, and after September 1960 with NASA, where he held the position of Associate Administrator, and in 1966, Deputy Administrator.

While Webb retained ultimate responsibility for policy and operations, as well as for White House and congressional relations, the competencies of the three determined an allocation of duties and at the same time enabled them to function as a team. Dryden's specialty was science, and he supplied scientific counsel and liaison with the scientific community, both at home and abroad. Seamans, the engineer, served as general manager and thus had responsibility for coordination of NASA's operations in field laboratories, research centers, rocket testing, assembling and launching facilities, and a world-wide network of tracking stations. Although Webb felt strongly that all three should be able to speak for the agency both internally and externally, he asked them to choose their fields of central responsibility. He took the rest, chiefly the responsibility for basic policy and collaboration with the President, the executive offices, other departments and agencies, and the leaders on space policy in Congress. In general, staff aides having external functions reported to Webb or to Dryden; those dealing with internal operations, including industrial activity, reported to Seamans.

Changes in the top directorate were occasioned, first, by Dryden's death in December 1965, and again by Seamans' resignation. Seamans moved into the position of Deputy Administrator in January 1966, and held it until January 5, 1968; he took his general manager function along with him and left the position of Associate Administrator unfilled for nearly two years. He was succeeded by Dr. Thomas Paine in March 1968, who became in turn Acting Administrator upon Webb's resignation effective October 7, 1968. Paine, then 47 years of age, was educated as an engineer and had spent most of his professional career with General Electric, first in project management in industrial science, and subsequently as manager of TEMPO, GE's center for advanced studies and interdisciplinary research for governments and industry. To the post of Associate Administrator, long held by Seamans, Dr. Homer E. Newell, previously head of NASA's Office of Space Science and Applications, was moved on October 1, 1967. Newell after beginning with a Ph.D. in mathematics and teaching that subject, joined the Naval Research Laboratory in 1944, and moved from there to NASA in 1958. He was an internationally known authority in the field of atmospheric and space sciences. Under Newell, as will be shown subsequently, a new orientation was given to the position of Associate Administrator.

An additional position in the top directorate was created with the appointment on March 15, 1967 of Harold B. Finger as Associate Administrator for Organization and Management. Finger's organization consolidated many of the numerous staff offices for administrative affairs that had been developed to assist the troika. Willis H. Shapley came from the Bureau of the Budget in 1965 and with the title of Associate Deputy Administrator, supervised the functional staff offices for Public Affairs, Congressional Affairs, International Affairs, and Department of Defense and Interagency Affairs. The organizational and personnel changes in recent years have been paralleled by changes in philosophy and practice in top-level administration. The early pattern of management and the transition toward a new pattern can be described most effectively after a look at additional elements in NASA organization and practice.

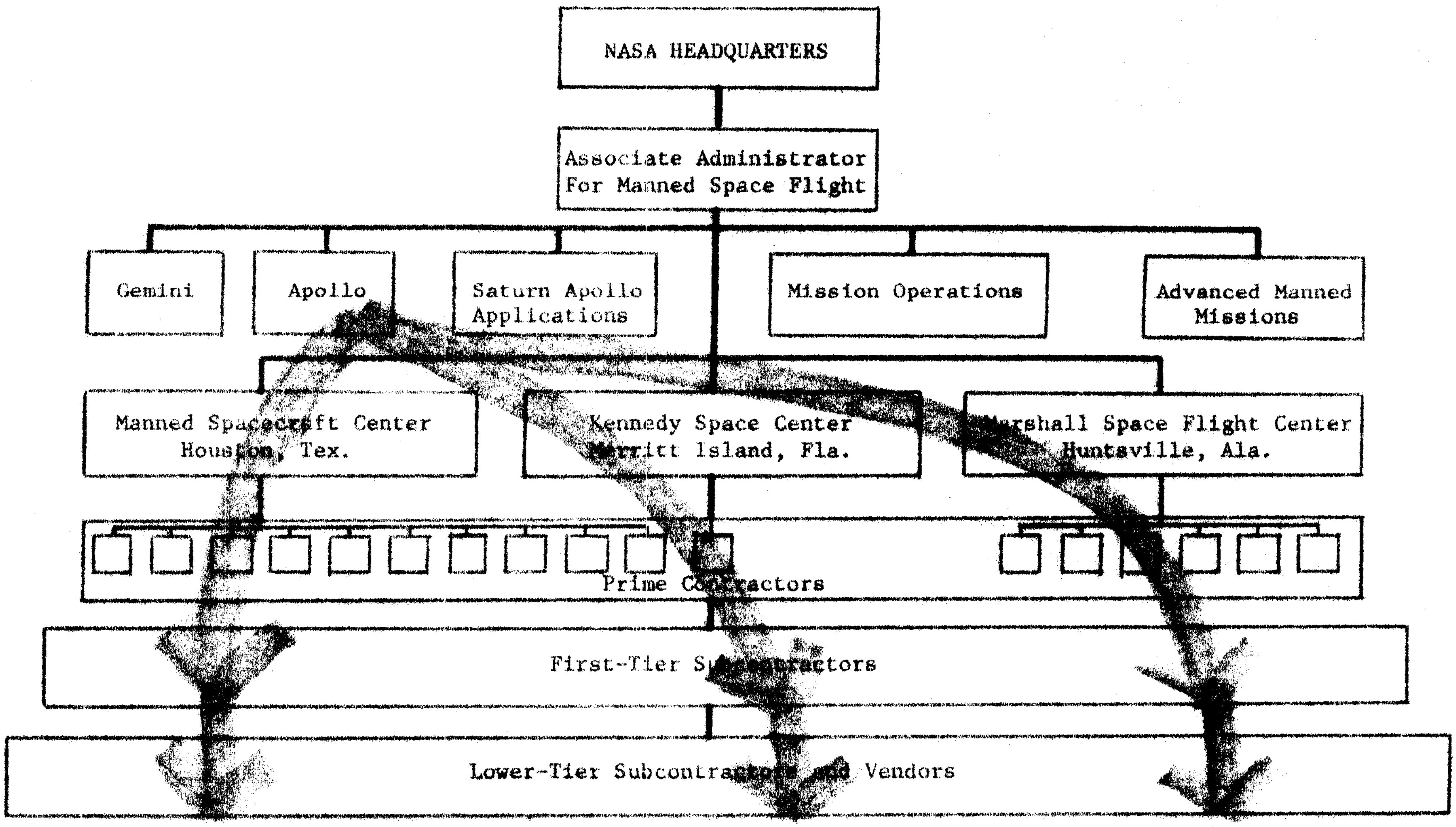
NASA's Program Divisions

Since November 1, 1963 program responsibility in NASA has been divided among four offices. The largest in terms of dollars expended and personnel engaged in activities is the Office of Manned Space Flight (OMSF) /see Figure I/. It has had responsibility for development of the hardware for manned space flight and for achievement of the manned lunar landing within the decade. It also has been responsible for planning, hardware development, and experiment integration for a follow-on manned space program after the first manned lunar landing. It is engaged largely in engineering and operations: development of the hardware capabilities for manned flight and the launching and direction of manned flights in space. Its activities include also the training and flight operations of astronauts.

A second division is the Office of Space Science and Applications (OSSA). It is more oriented toward science and less toward technology than is OMSF. It is responsible for defining scientific objectives in space, whether manned or unmanned, and for the application of knowledge and technology to operational systems, i.e., meteorology and communications. It too has an interest in flight equipment, for it has the responsibility for unmanned space probes and satellites and for hardware development for unmanned flights, as well as for scientific and technological experiments on the flights. It proposes scientific experiments to OMSF to be carried on manned flights and gives science support to that office, but to a large extent the OSSA has served the agency as an "unmanned flight" office.

FIGURE I

MANNED SPACE FLIGHT TEAM



Source: National Aeronautics and Space Administration, Manned Space Flight 1966, p. 18.

A third division is the Office of Advanced Research and Technology (OART). Its function is to develop the scientific and technological base for the nation's aeronautical and space activities. This ranges from basic research to engineering applications. It essentially inherited the NACA tradition, which placed emphasis on high-quality engineering development; but while remaining basically an engineering organization, it deliberately has expanded into pure aerospace research. Its responsibilities include (1) developing technologies for future aeronautical and space vehicles; (2) helping solve problems in vehicles being used or under development; and (3) increasing scientific and engineering knowledge for application to space vehicles and their operation. Among recent activities have been research on jet noise reduction, experiments in pilotable earth landing of spacecraft, development and testing of nuclear and solid rockets, testing of new fabrics for astronaut clothing, and studies looking toward feasible vertical, short take-off and landing aircraft.

The fourth division is the Office of Tracking and Data Acquisition (OTDA). Through a worldwide network of ground stations and related facilities, supplemented by Department of Defense stations and instrumented ships, it determines the location of a spacecraft or satellites in space. It receives and records data from space vehicles, and it communicates these data to mission directors, who in turn make decisions to be communicated to tracking stations or spacecraft for execution.

Centers and Contractors

To understand NASA one must know the pivotal role of its centers. Whereas policy-making, political representation and defense, and program integration and review are responsibilities of headquarters, operations are decentralized to centers. And in NASA the general term "operations" includes management responsibilities of vast dimensions. Also, this management responsibility carries with it more independence than normally exists either in U. S. industrial organizations or military field units. An industry executive recruited to NASA in 1968 compared center directors to warlords and headquarters to the king's court. He might have termed the former "baronies" and explained the power he saw in them as similar to that retained by erstwhile feudal chiefs in some early modern states.

NASA's centers came to it in three ways. First, it inherited from NACA the field installations in which its research had been conducted--the Langley Memorial Aeronautical Laboratory (later called Langley Research Center) in Virginia, Ames Aeronautical Laboratory (Ames Research Center) in California, Lewis Flight Propulsion Laboratory (Lewis Research Center) in Ohio, Pilotless Aircraft Research Station (Wallops Station) in Virginia, and High Speed Flight Station (Flight Research Center) at Edwards Air Force Base in California. Second, transferred to it were certain Defense installations, including the Army's Jet Propulsion Laboratory (JPL) in California in December 1958 (under contract with Cal Tech and technically not a center), and the Development Operations Division of the Army Ballistic Missile Agency in Alabama in June 1960, which became the Marshall Space Flight Center (MSFC). Also transferred were most of the Army's launch facilities at Cape Canaveral, Florida, which were to be expanded into facilities renamed the John F. Kennedy Space Center. Finally, it developed new centers, such as the Manned Spacecraft Center (MSC) in Texas. Sometimes new centers--such as the Beltsville Space Center in Maryland in 1959, later called the Goddard Space Flight Center (GSFC)--were staffed almost entirely from projects transferred from the Department of Defense.[5/] This was indeed the first new center; moreover, it was the first of NASA's development and operational centers, in contrast to the research centers inherited from NACA.

The centers reported after November 1961 to the top directorate of NASA, but in 1963 they were assigned to program offices. Assignment of some of the major centers and installations was as follows: to OMSF, the Marshall, Houston, and Kennedy centers; to OSSA, the Goddard Center, Wallops Station, and the Jet Propulsion Laboratory; and to OART, Langley, Lewis, and Ames.

The effect of this assignment of centers to headquarters offices in 1963 has been to produce a quasi-bureau type of organization within NASA. While the centers may engage in activities that are of large significance to the operations of more than one division they are aligned by overall direction and affiliation with the division of which they are a part. They operate, moreover, with a level of supervision separating them from the top management of the agency. This separation is mitigated only partially by functional management of the staff offices at the top management level, through which legal, procurement, and budget reviews are made over operations at all levels.

A number of factors produce a large measure of responsibility for the centers. The first of these are certain management concepts on which agency operations are built. The headquarters function, according to these concepts, is determination of policy and program objectives, outline of the framework of management controls, and review to determine how well program objectives are being achieved. Operations is decentralized to strong field installations. Program directors in the headquarters Offices, responsible for such programs as Gemini and Apollo, have

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With respect to NASA acquisition of centers, see Rosholt, An Administrative History of NASA, 1958-1963, particularly pages 21, 45-48 and 107-12.

maintained such management control systems as would permit effective decentralization to project managers in the centers. These have local authority, under the management supervision of center directors, for attaining assigned missions according to time schedules, which will have been determined collaboratively by headquarters and center officials. Integration of project management with other activities is the responsibility both of the center director and the headquarters program manager. Agency regulations provide for functional direction of project managers in the centers by program managers at headquarters, and direct communications between the two is regular and frequent. This may be supplemented by direct oral or written communications between the heads of still other organizational divisions operating under the program manager and their counterparts operating under the project manager in the center.

The responsibility of the center director and project manager is the result primarily of another factor, namely, the expertness of the center staffs. Expertness in depth and the capacity for operations is in the centers. A strong base of research and technological competence was obtained in the proven research laboratories and construction capabilities transferred to NASA from NACA and the DOD. This was supplemented by expansions in facilities and personnel and by NASA's practice of building new centers, which could assume wherever possible extensive responsibilities and serve many uses and use many contractors.

In addition, the center is NASA's contact with the contractors. There is variation among the centers in the extent to which there is in-house research and design development. Marshall, for example, inherited the arsenal concept, and has engaged in the past in much more in-house development than does Houston. Yet Marshall, too, depends on engineering support from contracting and is now out of manufacturing. The extent of use of contractors is shown in the fact that in 1966 approximately 34,000 persons were employed in NASA headquarters and centers, and about 386,000 employed by contractors and universities on NASA projects. Contractor negotiations are conducted by the centers and contractor work is performed under the direction and supervision of the centers. Project managers and center directors, while subject to many limitations on contractor choice and terms, have the responsibility for the effective contractor performance required for mission success. They also integrate the contractors into the decision-making process on project changes and origination of new projects. While the centers carry the responsibility, their operations are dependent upon a partnership with contractors.

The responsibility, even the independence, of the centers is supported by the latitude granted to them in the use of funds. Normally the program offices delegate to the centers the authority to shift funds within an approved "project," subject to the agency limitation that there is no change in the scope of the project, its intent, or a major change in launch schedules. This may create extensive discretion in the center director if the project is a large and expensive one. For example, the Apollo program was broken into five projects. One of these was spacecraft, and the resource allocation for this in fiscal year 1968 was approximately $1.1 billion. This allocation was broken into five subprojects, with approximate amounts as follows: Command and Service Modules, $450 million; Lunar Module, $400 million; Spacecraft Support, $113 million; Guidance and Navigation, $66 million; and Integration, Reliability, and Checkout, $60 million. These allocations by headquarters were in such large amounts that the ability to use allocations created great discretion, but beyond this the center director could shift from one subproject to another (e.g., from Lunar Module to Command and Service Modules). In addition, funds are sometimes used jointly for two programs. Thus, on one occasion NASA auditors alleged that money from Gemini had been used for Apollo, but the budget office in NASA disagreed on the basis that it was a case of use of funds on overlapping programs. Finally, the center director may find that he has a considerable degree of latitude in the use of AO funds for assistance to project development.

There are checks and balances that operate to contain the discretion of the center directors. The budget officer has the usual controls over agency expenditures. In addition to phasing of funds through apportionment and checking to see that expenditures do not exceed accumulated authorizations or special congressional limitations, he receives biennial operating plans from all parts of the agency and reports of any changes from allocations. Yet on either the operating plan or subsequent changes in allocations, he is reluctant to interfere with the discretion of those who bear the responsibility for project success. He recognizes, moreover, that R&D expenditures cannot be defined precisely in advance in the same way that most government expenditures are. There is an additional control in the requirement that the Administrator approve contracts above stipulated amounts. Also, the associate administrator for OART must approve use of funds for supporting research and technology. Such studies are the subject initially of agreement between the center and the program division in Washington, and may run into objections thereafter either in OART or from the top level of administration.

Work normally is carried out with understanding between headquarters and centers producing explicit or implicit agreement. Inevitably some of the strains that usually accompany physically-separated field and headquarters stations occur. The attitude in the centers is, "Give us the money without tight strings, leave us alone, and we'll do the job." The attitude in headquarters is, "We must know what you are doing, whether it is in accord with overall agency program, and whether it will get us in trouble with Congress." Headquarters staff emphasize the discretion that resides in the centers, while the centers call attention to headquarters controls over the many technical studies that they originate. The problems on such studies were indicated by an exchange of correspondence after a rather heated conflict over a study contracted by Houston in 1967. The Director of Earth Orbital Studies in Washington asked the Chief of the Advanced Spacecraft Technical Division in the center to rescind a revision it had made in instructions to the contractor, and a series of meetings were necessary to resolve an ugly disagreement over what had been the purpose of the study. After the incident the Director of the Advanced Manned Missions Program in OMSF wrote to the Chief of the Advanced Spacecraft Technical Division in Houston to suggest that the work program set forth in study proposals should be more explicit so as to avoid misunderstandings. The center official replied with emphatic disagreement; he urged that, while better understanding between their respective staffs was essential on future studies, specificity in the work statement would create difficulties for both of them because work statements went through an approval cycle at the top level of the agency. Approval of work plans with flexibility in implementation is the objective of procedure, but avoiding, on the one hand, "multi-million dollar hobby shops" in the centers and, on the other, aborting results by rigid prescription, is a difficult task.

Competition for work or conflict over objectives, or the best means of attaining them, sometimes exists between the centers, and these may seek to obtain support from the respective headquarters Offices to which they report. Examples of these differences will appear in the case study that is presented in this volume. There are, finally, differences among centers in leadership characteristics and management philosophy. This is clearly revealed in the contrasts between the Marshall and Houston centers. Dr. Wernher von Braun, center director at Marshall during the period of this study, is a national and international figure and is helpful to NASA in congressional appearances because of his status as a space celebrity with much stature in Congress. Robert R. Gilruth, director at Houston, often shuns a public role and gives much less attention to political contacts. As has been noted, Marshall and Houston differ on the amount of in-house activity. The idea that contractor competition in project design will bring out new ideas and reduction of costs is reflected in Houston's practice. The Marshall center in the past has been staffed more adequately on in-house studies and project design and continues to follow its traditional practice of carrying out a larger portion of its task through its own personnel.

The effects of the socialization of personnel to the tasks, perspectives, and loyalties of separate units of organization are moderated by the communication network in the agency. There also has been some transfer of personnel across internal divisions, in large part as the result of pressure to find talent for critical tasks. Thus, Joseph Shea, after working in headquarters in OMSF, became manager of the Apollo Spacecraft Program Office (ASPO) in MSC, and George Trimble moved from the Advanced Missions office in OMSF in Washington to the position of Deputy Director of MSC. Notable is the case of George Low who was Deputy Director of OMSF, then Deputy Director of MSC, then after the Apollo fire in January 1967 director of ASPO in MSC--an example of the use of a person where he would be most effective. Such transfers of personnel are notable because exceptional and did not alter the basic allocation of operating responsibility to the centers.

There are factors, in addition to the normal supervisory and communication techniques, that moderate the effects of the heavy concentration of responsibility in the centers. Cooperation among such centers as those at Huntsville, Houston, and Cape Kennedy is forced by the necessity for integration of their technology and management in space flight. The headquarters Office is a continuous center for initiation of technological and policy studies, and frequently the composition of study groups includes both headquarters and center personnel. Moreover, the center directors and their subordinates participate regularly in program reviews and policy deliberations at the several levels at which these occur at headquarters.

The Manned Space Substructure

One frequently hears reference in NASA to the "manned space family." In Chapter I we explained the concept of "political subsystems" within the political system. This term refers to the interacting administrative agencies, congressional committees, and interested private organizations that give their continuing attention to policy and administration in a particular area, such as defense, education, Indian affairs, or river and harbor development.6/ Under this concept one

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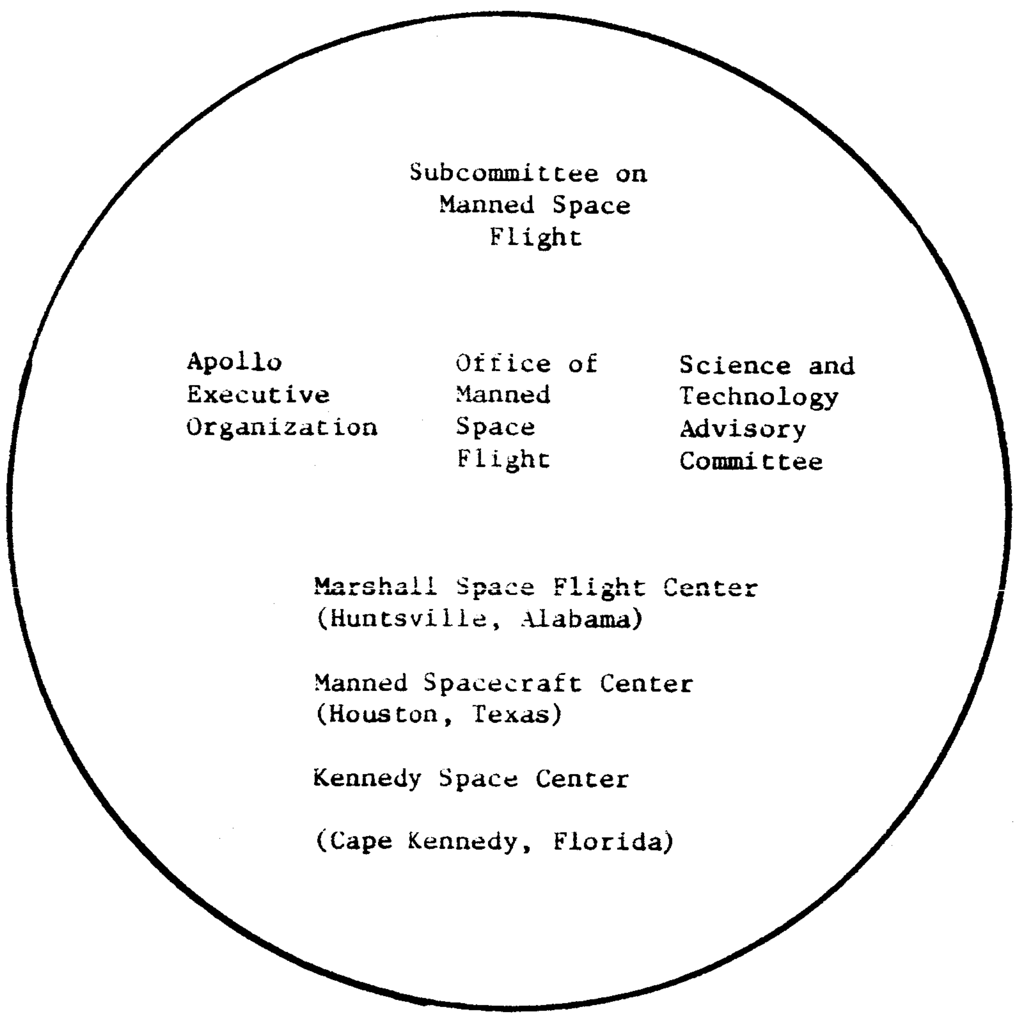
6/ For analysis of three subsystems, see J. Leiper Freeman, The Political Process: Executive Bureau-Legislative Committee Relations (2nd ed.; New York: Random House, 1965); Arthur Maass, Muddy Waters: The Army Engineers and the Nation's Rivers (Cambridge, Mass.: Harvard University Press, 1951); and Emmette S. Redford, "A Case Analysis of Congressional Activity: Civil Aviation, 1957-58," The Journal of Politics, XXII (May 1960), 228-58. These three subsystems are compared and further analysis of the concept provided in Emmette S. Redford, Democracy in the Administrative State (New York: Oxford University Press, 1969), Chap. IV. Douglass Cater calls the subsystems "subgovernments," and illustrates the tightness or looseness that may prevail in the interrelations within the subgovernments. See Power in Washington (New York: Random House, 1965), Chap. II.

CHART IV

MANNED SPACE FAMILY



would expect to find a civilian space subsystem in the governmental system composed of NASA, the four congressional committees primarily concerned with space, and contractors and science organizations. In the case of civilian space, one can move a step further and see the manned space family as a sub-subsystem composed of the associated organizational centers continuously interested in the Apollo program system. The sub-subsystem contains the administrative structure that is devoted exclusively to civilian manned space capability and includes additional elements that give it significance in the politics of space.

The pivot of this administrative-political system (sub-subsystem) is the Associate Administrator for OMSF, a position held since September 1, 1963 by Dr. George E. Mueller.[7] Mueller, educated as an engineer and physicist, became professor of electrical engineering at Ohio State University, then served five years in Space Technology Laboratories, Inc., Redondo Beach, California. Technical author, holder of patents in electrical engineering, and responsible prior to coming to NASA for design, development and testing of missile systems and development of space projects, he had responsibility in NASA for the effective administration of the manned space programs. Moreover, his position demanded that he provide representation for manned space programs in the top councils of the agency and participate in the promotion of manned space capability in centers of influence and decision outside NASA. In these latter tasks--the internal and external political tasks of an administrator--he was positive, imaginative, and aggressive. Mueller remarked to the writers that his job was only 40 percent technical administration.

Key officials in Mueller's administrative operations were Lieutenant General Samuel C. Phillips (United States Air Force), program director for the Apollo program, and the directors of the three centers that reported to the head of OMSF. In the Apollo program Von Braun's organization at Huntsville had responsibility for development of rocket capability, including production of the Saturn IB and Saturn V boosters. Gilruth's organization at Houston performed three functions. Although shared now to some extent with Huntsville, a first function at Houston was the design, production, and testing of spacecraft, now primarily the Command and Service Module (CSM) and Lunar Module (LM). Its second function was the training of astronauts, and its third was flight and recovery operations in manned space flight. It had responsibility for mission direction and operations after the firing of launch vehicles. Dr. Kurt H. Debus, who came to the United States from Germany in 1945 with Von Braun, directed the launching facilities and the integration of space vehicles at Cape Kennedy. The three center directors had occupied their positions from the establishment of their centers. Mueller, Phillips, the center directors, other technical staff in Washington and the centers, and the contractors provided the engineering and engineering-management capability for the administrative task of Mueller's OMSF.

7/ In December 1969 Mueller resigned from NASA and joined the General Dynamics Corporation.

A short time after he joined NASA in the fall of 1963, Mueller took three steps to enhance the degree of communication and coordination with organizations outside NASA. The result of these steps was an expansion of the manned space flight family to include, in effect, three supporting groups. One group consisted of the principal industrial contractors associated with the program. A second was focused on a committee of distinguished scientists and technological specialists. The third consisted of committees and members of Congress immediately concerned with the manned space flight program.

The principal contractors in the Apollo program were organized as the Apollo Executives. The vast Apollo hardware production is under contract to about 20 prime contractors and several thousand subcontractors, suppliers and consultants. Mueller, the three center directors, and the chief operating officer of each prime contractor met regularly, normally quarterly, for discussions that range into policy questions. Such an organization may be useful for purely administrative purposes. Thus, a similar Gemini executive organization was presented the decision of NASA to accelerate the Gemini program by six months. Communicating this tough directive through the usual channels could have resulted in some lack of clarity and failure to enlist cooperation. The executive organization met, the executives' objections were heard and answered, and the decisions went directly to all the major companies.

Yet other roles of the Apollo Executives may be more significant. It is a medium for keeping the executives knowledgeable, for interchange of opinion, and for policy discussion. Thus, at a two-day meeting in Phoenix in November 1965, there was discussion of the kind of manned space program that should follow Apollo, and a NASA official who was present believes that this was an important stage in planning the post-Apollo program. The executives, moreover, may be brought into meetings with the subcommittee on manned space flight in the House space committee. Such meetings partially can take the place of a space lobby. In addition, individual members of Apollo Executives have arranged for the director of OMSF to make public addresses to groups of executives in major cities, or for him to meet with such groups at dinner. In these several ways the executive organization serves as part of the space family.

Another extension of manned space organization by Mueller was the creation of the Science & Technology Advisory Committee for Manned Space Flight (STAC). OMSF has not needed and hence has not developed the numerous contacts with the science community that have developed in its sister offices--OSSA and OART. It does have some contacts, as for example in Houston, where biomedical experts assist in the program of testing flight effects on astronauts and where arrangements are being made for scientists to examine the payload returned from the moon. It has had various forms of collaborative arrangements with OSSA, dating back to the creation in 1962 of the temporary Manned Space Flight Division in OSSA, whose director, Willis B. Foster, reported to the heads of both OSSA and OMSF. Mueller and other officials in OMSF also attended relevant meetings of the President's Science Advisory Committee (PSAC) as requested. Yet the contacts with scientists directly or through OSSA were regarded as insufficient, and Mueller and other officials decided to establish a Science and Technology Advisory Committee.

STAC, while set up as the Administrator's committee, in fact remained the door between Mueller and the science community. It is an interdisciplinary committee with some overlapping membership with PSAC, and was headed from the beginning by Dr. Charles Townes, when appointed Provost at the Massachusetts Institute of Technology, and later at the University of California at Berkeley. On at least one occasion, it met jointly with PSAC. It provided representation for science in the formation of manned space policy. At the same time, Mueller had a knowledgeable group within which he could gain understanding for his program. While there was some criticism of manned space programs within the committee, it was a source of support and constructive assistance.

The most important extension, however, of Mueller's efforts to create external support was liaison with Congress. Operating on the assumption that knowledge about the manned space program would create support, Mueller set up means for dealing directly with the members of Congress who were in a position to help or hurt the manned space program. Within the House space committee, there were three subcommittees that were counterparts to OMSF, OSSA, and OART, and that conducted annual hearings on the portions of the authorization bill relating to these three offices and made recommendations to the full committee on authorization amounts. The chairman of the subcommittee on manned space flight was Congressman Olin Teague (Dem., Texas), who also was chairman of an oversight subcommittee from 1965 to the time of this writing. Teague had been chairman of the House Committee on Veterans Affairs and told the writers that he had said to the Speaker of the House that he wanted an assignment to something that was new and offered promise of significant development in the future. Placed on the space committee, he became a knowledgeable and ardent supporter of manned space capability, chiefly because he regarded it as important in the nation's defense posture. Mueller and Teague became close friends and were in contact with each other, by Mueller's estimate, on the average of twice a week.

Within the framework of NASA's overall relations with Congress, Mueller created arrangements for keeping the House subcommittee informed and enlisting its support. Twice a year the subcommittee visited the manned space flight centers, and also on occasions contractor sites. Part of the authorization hearings were held at centers, and at these hearings contractors as well as center directors could make presentations. There were opportunities also for social visits with center personnel and contractors. In addition, approximately once a month the subcommittee was invited to a briefing at NASA headquarters by OMSF officials. Members of the Senate space committee were invited also, but being busy with other matters they soon ceased to attend. Finally, after Teague had expressed a desire for the subcommittee and staff serving it to deal directly with technical people, a group of people with technical training was assembled in OMSF for assistance to the subcommittee. To direct these people and be responsible for liaison with the Apollo Executives and Congress, Mueller enlarged the functions of an office bearing the label "Field Center Development." Its director, Captain Robert F. Freitag, was able to service the demands of the manned space flight subcommittee and other members of Congress for information.

It will be apparent, as the case study on post-Apollo manned space flight decisions is presented, that this sub-subsystem, and particularly the relations between OMSF and the House space subcommittee, was an important means of informing Congress and focusing the issues for congressional attention.

Procedures

Decision-making and decision implementation in flexible and developing programs are not fully distinct processes; each interacts with and influences the other. Moreover, both are enveloped in the letter and practice of procedure. Management procedures inform the decision-makers and focuses the processes of decision. Those within NASA that may have a material effect in these ways are sketched here.

The basic procedure is called "Phased Project Planning," a procedure that originated in the Department of Defense. Used in NASA for "aeronautical or space projects that require significant resources or involve important external relations," it "normally progresses through four stages, each of which must be approved by general management." The first, "'Advanced Studies' /later called 'Preliminary Analysis'/ is directed at the analysis of technical means for satisfying the objectives of the Agency and takes into consideration a number of alternative approaches or concepts for satisfying these objectives." The second phase, "'Project Definition,' is directed to the development of a single project plan from among the alternatives studied." The third, "'Preliminary Design,' provides for design of critical hardware including development of critical systems and of subsystems, through breadboards, and development of the final project plan." "The last phase, 'Development and Operations,' includes final hardware development, fabrication, test and operation."

The significance of this procedure is that it provides an opportunity for "phase-by-phase decision by general management." This has important consequences. It enables the agency to study various alternatives before committing large resources, and hence it "minimizes the Agency's risks as well as those of the contractors." It gives a chance to offices and centers within the agency, in-house or by contract, to carry competing projects through early stages, with opportunity for "survival of the fittest" projects. It fosters a tendency, inherent to an extent in R&D planning, to initiate and pursue many projects at early stages, and even to allow repetition and overlapping in advanced studies. Studies, financed out of many pockets of money, may be approved readily, and agency decision delayed or not even seriously contemplated in a near time frame.8/

This process also allows opportunity for extensive dialogue on technical alternatives. Study committee reports may move into an arena of conflicting ideas and conflicting stakes of different parts of the agency, and differences be resolved or choices made after discussion, argument, and perhaps additional studies. On the technical level, decisions, one official said, are made in "a forum of continued exchange." The agency meanwhile bides its time on policy decisions.

Additional management processes grow out of two forcing factors: resource allocation and time schedules. The greatest constraint on decisions, other than technical factors, is budget limitation. The annual budget cycle forces decisions into a procedural pattern. Thus, preliminary estimates for fiscal year 1968 were sent to the Bureau of the Budget in the spring of 1966, and after discussions with the Bureau final estimates were sent in the fall of 1966. In the spring and summer of 1967 presentations were made to the four congressional committees. The decision of Congress in recent years has not been made until months after the new fiscal year begins. Hence, the agency did not get its budget for fiscal year 1970 until the fall of 1969. Thereafter it prepared an operating plan in considerable haste after a series of meetings at the top level of the agency. At this point the head of the agency had to make many of his most critical decisions, finally deciding on the elimination or reduction of funds for projects, or on the granting of additional funds, within allowable limits, to projects Congress had dealt with parsimoniously. He then reported his operating plan to congressional committees, meeting in executive session.

8/ The quotations are from Seamans' statement in U. S. House, Committee on Science and Astronautics, Subcommittee on NASA Oversight, Future National Space Objectives, Staff Study, 89th Cong., 2nd Sess., 1966, pp. 47 ff.

Still further cuts below those made by Congress can come from the President, and call for later adjustments. As a part of the process the users of the money must report twice a year internally on how the money is to be used.

Within NASA,projects are approved by the Project Approval Document (PAD). The approvals are given at the top level after moving up the hierarchy. A PAD may be issued for an entire program, as was done for Apollo. Normally one is issued for each project in a program, but sometimes approvals are given individually for parts of a project. Sometimes, however, the specific procedures are not followed; thus the Gemini PAD was approved after the project was terminated. Moreover, a PAD does not automatically get money for a project. Financial approval also must be given, and the Administrator may require special approvals for particular steps in execution of the project. The Administrator recently, however, has tried to tighten the controls through the PAD by coupling consideration of project, money, and schedules, and specifically by carrying the schedule in the PAD.

Planning in NASA normally is done on a time schedule, geared usually to launch schedules. Schedules set the pace of implementation of program plans. Schedules may "slip" but new schedules then are set. To achieve goals on a time schedule, NASA employs the PERT concept, developed in the Navy Polaris program. PERT is a system that breaks down specific tasks in terms of time allotted for sequential stages. It provides management with precise information as to the longest path in development of a project in terms of time, referred to as "negative slack." It helps identify the tasks that must be accelerated. NASA found it necessary to computerize PERT, for the Apollo program was broken into numerous "work packages" and thousands of specific tasks.

To implement planning on a time schedule further techniques are employed. Trend charts are developed from PERT data to show the pace of particular segments of the program or project. (In studying NASA one soon learns to look for everything on a chart.) "Pacing line items" are identified and "work-around" techniques developed for operations that are proving to be slow or create obstacles. Milestone schedules have been set up for major research and development programs. In Apollo, configuration management, adopted from Air Force practice, has been used as a technique of coordination. Its purpose is the control of changes, such as those in engineering design following a failure in performance tests. Change proposals were reported, hardware identified, the changes approved, and verification of the change made through the feedback loop. This was a very important near-term decision-making mechanism--a device for making many related decisions on budget, operations, personnel utilization--and could operate effectively when the right people were present and the appropriate person chaired the discussion. In addition, review boards made evaluations of hardware readiness, flight readiness and other key technical points, sometimes at the center level (with contractors facing government) and sometimes at higher levels. At a higher level, perhaps 250 people have sat for 2 or 3 days with the Program Director of the Apollo program to determine the readiness of all parts of the program.

While these and other techniques are employed, NASA management has used the monthly review as the main means of getting information at successive levels on progress attained and of spotting the need for new decisions. When Seamans became general manager in 1961 he found this management technique in process of development, and he developed it as his technique for checking on programs that were underway. Initially, the review brought together Seamans, the heads of program offices and Seamans' staff (and for a time the Administrator and his deputy, with Seamans presiding), and a separate meeting was held by Seamans with each head of a program office and members of his staff. In time, however, Seamans' monthly reviews were held separately for each program office. The program reviews at Seamans' level were preceded each month by reviews at lower levels of the agency. Thus, the monthly review cycle became the means of reviewing the progress of established programs, with the budget cycle being the review process for new planning. The monthly reviews for the program offices were supplemented, moreover, by reviews of particular programs. Seamans would prepare for these well in advance so that Webb, in attendance at "Program Reviews," could get a clear and adequate presentation.

For one type of decisions, those on procurement, there is a special process. For center contracts, the following are the main steps in the process. A procurement plan is written at the center, but must be approved by the Administrator for legality and also for permission for a noncompetitive contract above $2.5 million. With specified exceptions, a Source Evaluation Board (SEB) is created and members named, by letter signed by the center director if the amount is estimated to be less than $5 million, and by the appropriate headquarters authority if a larger sum is involved. The SEB prescribes the criteria for weighing proposals and bids are requested from contractors. The SEB evaluates the bid proposals, with technical and cost considerations first being considered separately, and with tightly closed procedures--designed to prevent favoritism in awards--which inhibit report by members of the SEB even to their superiors. The SEB recommends a contractor or contractors, and final approval is made by the center director if the amount is less than $5 million and by the Administrator if the amount is more than that. Normally, the latter decisions were made in conference between Webb, Dryden, and Seamans, and after Dryden's death by Webb and Seamans. Obviously, these are decisions that implement program and project plans already developed. Webb has said to the authors that there was never a case where he was "surprised" on agency plans at the stage of a procurement application.

There are occasions when other approvals are required. For example, the Administrator may retain for himself the approval of extensions of contracts when funds are short or he is unwilling to give a commitment in advance on continuation of a project.

Top Level Management: Problems and Changes

The top level directorate, program offices and centers, program and project directors, and management procedures adapted to the requirements of a large engineering organization, provided the framework of NASA operations. In time problems arose in overall agency management of the structure, and changes were made to incorporate new management concepts.

In large part the problems arose from the lunar landing decision and the organization developed following that decision. The establishment then of the four program offices and the subsequent transfer of centers to these offices placed all of the responsibility for hardware development, construction, and training and operations for the lunar landing in the OMSF. This office had the bulk of the money and the primary program goal, and its program emphasized technological capability as the objective. In time intense and sometimes bitter conflict arose between this office and other offices, particularly OSSA.

While the existence of the conflicts is common talk in NASA, explanations for it differ in their emphases. It is stated often that the conflict between OMSF and OSSA has its basis in the "philosophical" issue of manned versus unmanned space flight, with scientists feeling that the needs of science can be met best on automated equipment or by allocation of resources to the form of space flight that is inexpensive and could be adapted more easily to various missions and experiments. The conflict, however, takes an institutional form: OSSA's orientation is toward science and toward applications (as its title implies), in contrast to OMSF's interest in technological capability because of the requirements of the lunar landing and other manned programs. Yet OSSA, too, has contractors and centers developing technology for flights, and its argument that science payloads can be carried more cheaply on unmanned than on manned flights may be motivated both by its science and applications orientation and its flight hardware program. The controversy was sharpened as OSSA sought to prepare experiments for manned flight and found that these had to be altered or abandoned in order to conform to the technological objective that was dominant in manned flight programs. Some officials say quite frankly the struggle is a "fight for bucks." Others refer to minor causes, such as the irritation in OSSA because it has to ask for many clearances for various projects, while OMSF has a standing clearance for Apollo, or the irritations in OSSA occasioned by OMSF's superior strength or a belief that it sometimes does not give timely notice to OSSA of projects on which its cooperation is needed. Notation of these irritations may explain the comment of one high official that the conflicts sometimes have been highly emotional.

A feature of the system that developed in the Apollo program was the layering both of technical coordination and political representation. The headquarters technical and management review was made at three levels--the program manager, the associate administrator for OMSF, and the general manager. The program manager has had the primary responsibility for program integration and success on a schedule. As the Apollo 7 flight was being planned in 1967, Webb even delegated, in the presence of Seamans and Mueller, final decisions on all equipment to Phillips. Mueller had peculiar coordination and planning roles because of the overlapping in time sequence of Mercury, Gemini, and Apollo programs, and post-Apollo planning, and both Seamans and Mueller because of need for correlation between OMSF and other divisions. So much of the agency's reputation depended on Apollo that Mueller and Seamans each sought assurance by his own review that all was going well, on schedule, in the program. There was, as a result, much duplication in the function of the two officials. At the same time, Mueller, while operating between two levels of technical review, developed--as described above--his own means of political representation, thereby obtaining a share of the top-level political function. The result was a layering also of the function of political representation.

Seamans' attention as general manager inevitably centered heavily on the Apollo program and drew him into close contact with Mueller. The two men lived in Georgetown with only a few houses separating them, and Seamans has remarked that he frequently went to Mueller's home to discuss problems. The Seamans system of holding program reviews separately for the program offices tended to prevent the airing of problems on an agency-wide basis and led to each office director trying to sell his program separately to Seamans. Within the agency one heard comments commending the Seamans system of monthly program reviews and other comments that it failed to create an agency-wide perspective. Seamans himself, in an interview with one of the authors, showed pride in the effective review of performance against time schedules that he had evolved, but said also that as the agency had moved into a period when new policies were to be developed, the Newell approach, to be described presently, might be appropriate.

The complaints against top management heard generally in large organizations were heard also in NASA. Center officials have said that there were too many layers between them and top management, and also that they had to deal with too many minor barons in the headquarters office. Headquarters complaints are voiced that clearances have to move through too many staff officials in the Administrator's office.

By 1967 three things had occurred that led to changes in managerial approaches. The troika was gone, and Webb was left with the task of allocating responsibilities at his level to new men. The fire in January 1967 on the launch pad at Cape Kennedy, taking the lives of three astronauts, concentrated national attention on the management of NASA: such incidents, whether attributable to the faults of top managers, bring the critics to their doors. And, finally, Webb became convinced that he had been separated from his organization by the Mueller-Seamans coordinating controls.

Webb, president in 1966-1967 of the American Society for Public Administration, is an administrative theorist. As he made pragmatic changes in his organization after the Apollo fire in January 1967, he explained structural and procedural changes in terms of countervailing power, functional management, and participative management.[9] But the basic motivation was to flush the issues of policy up to Webb and get an agency-wide perspective in their consideration.

Part of the change that occurred was a deeper involvement by Webb in internal management. Following the fire he appointed task forces under Phillips and Frank A. Bogart (Lieutenant General, U.S.A.F., retired) and asked these to report to him in the presence of Mueller. Further illustrating this trend, in 1968 he asked Harold Luskin, new head of the Apollo Applications Program in Mueller's OMSF, to keep him informed by direct communication, and at the same time he required contract renewals on this program to be sent to him for approval.

In the revised organization the office of the Administrator included Webb, Paine as Deputy Administrator, and Willis H. Shapley as Associate Deputy Administrator. The internal arrangements for countervailing power, functional management, and participative management centered around the functions of two new associate administrators--Harold B. Finger and Dr. Homer E. Newell.

9/ See James E. Webb, Space Age Management (New York: McGraw-Hill, 1969). This is an expanded and modified version of the Columbia-McKinsey lectures Webb delivered in 1968.

Finger became head of the Office of Organization and Management in 1967. Forty-three years of age at the time of this appointment, his entire career had been spent in NACA and NASA. Although this career was in technological research and engineering management, the new office to which he was appointed integrated many of the administrative management functions. Yet the assumption was that a strong management office, with delegations and clearance functions sufficient to create a base for functional management, could serve as a check and balance on the program offices and open windows to the Administrator on policy as well as on administration. Finger sat in the top councils of the agency, was expected to have an agency-wide perspective, and served as a counterpoise to the program offices.

Newell, science-oriented and previously head of OSSA, was given the responsibility for agency planning. At the time the agency was seriously responding to the government-wide PPBS effort, and hence his management processes were adapted to the coordination of planning and budgeting. The processes were designed to provide peer group participation, across divisional lines and reaching downward in the organization, on critical agency problems. Just as Finger's operations united management functions, so Newell's unified planning functions; and both functions were to be integrated with program office representation in top policy consideration. Newell's concept called for integration of planning with line management. He also desired a form of planning that would bring options to the top.

At the top of Newell's management structure was a Management Council, composed of the principal line and staff officials--that is, Mueller and the other heads of program offices, Finger, Shapley, the General Counsel, and others. This council met every Monday afternoon with Newell presiding. Webb did not attend, but Paine as deputy administrator sometimes attended. There was also a monthly status review with the same people attending. With direction and oversight from the management council a Planning Steering Group (PSG)--also chaired by Newell and composed mainly of the center directors, the deputies to the principal officials (e.g., Finger's and Mueller's deputies), and the chief planners of the program offices--laid out the planning program. It determined the areas of programmatic coherence, such as lunar exploration (manned and unmanned), planetary exploration (manned and unmanned), space applications (manned and unmanned), launch vehicles, space biology, institutional support (centers, etc.). Working groups, chaired in each case by a line official, were formed for each of these areas. These were asked to analyze the likely range of objectives, and in conformity with this the ranges of projects and program elements and the corresponding ranges of resource requirements. They were to pick a benchmark at which funding might be available, and establish ranges spanning the benchmark above and below. In this way, maneuverability would be created for the Administrator. From the working blocks provided by the working groups, PSG would assemble sample total programs corresponding to different strategies and to different budget levels. The purpose at this level of planning was to show options, impacts, and other factors relevant to choices.10/

Finger's operation was well-established and generally accepted in 1968, though not without considerable complaint in program offices that it had added additional clearance obstacles. Newell frankly stated that the first major test of his planning system would come in the preparation of the fiscal year 1970 budget in October 1968. It is clear that, as Webb left the position of Administrator in October 1968, the agency had moved into a new stage, with new management concepts.

The Political Superstructure

With respect to future policy, the necessary function of the administrative structure subordinate to the Administrator of NASA is to study and report on technical and administrative feasibilities; this minimal function may be accompanied by proposal of policy and by planning that focuses the alternatives and even determines the directions in which it may be possible for policy to move. There will be ample evidence in the case study that follows that the subordinate structure did perform these latter functions. The Administrator, while he may initiate and set the directions of study and policy analysis, will ultimately have the function of hearing and deciding. On policy decisions that will require political support, his decisions will become recommendation of proposals or report of alternatives to the political superstructure. While initiatives may come also from this political superstructure, the unavoidable, residual function is to hear and decide. In the political system of the United States, this function lies first in the normal sequence of events in the presidency, and then in the Congress. The first is an area of concentrated responsibility, the second an area of diffusion of public responsibility among many persons, but with substantial counteraction of this diffusion by allocations of leadership and preliminary decision to persons strategically located for influence in the committees of Congress.

10/ This description is based partly on a written analysis but is largely in the words that Newell used to describe it in an interview on September 17, 1968. The pattern still was being instituted as the period covered by this case study came to an end.

The Presidency

With respect to manned space flight the general character of the President's participation has been patently evident. The lunar landing objective was selected by President Kennedy, and under the conditions that existed his decision was readily and strongly confirmed in the Congress. Similarly, Chapter V will reveal that President Kennedy in 1963 and President Johnson in 1964 initiated moves to bring into focus the issues with respect to a future space program, manned and unmanned. Since that time the President's function has been to hear and decide on the various alternatives, and levels of support for these, which have been presented from NASA and DOD.

President Johnson's period of service approximately corresponded with the period of the case analysis presented in this study. Several factors illuminate the background of his participation, and serve to illustrate the importance of personal factors and also of contextual factors in decision-making. He was informed by experience on the space program. He had offered leadership for the passage of the Space Act. He had been first chairman of the Senate space committee and President Kennedy had made him responsible for advice on the space program. Also, he was known as a strong advocate of American leadership and primacy in space technology and exploration. In addition, he had recommended Webb for the position of Administrator, and hence could be expected to have confidence in the administration of NASA and its ability to chart a future course in space technology and exploration. And yet, in contrast to these factors favorable to bold space adventure and to smooth relationship in development of a space program, the President was in the period of our analysis facing budget stringency occasioned by the Great Society programs and the Vietnam War, and hence the claims of space on budget resources had to be measured against extreme urgencies in other areas.

The National Aeronautics and Space Council. Students of American government are familiar with the establishment by Congress of special offices within the Executive Office of the President--such as the Council of Economic Advisers and the National Security Council--to assist the President in certain areas of public policy. They also know that the use of such offices may vary with different Presidents. The Council set up by the Space Act of 1958 was virtually inoperative and had no staff or executive secretary during President Eisenhower's administration, which proposed its abolishment in 1960, and received House approval. President Kennedy decided to activate the Council. He appointed Edward C. Welsh as its executive officer in March 1961, and obtained an amendment to the Space Act that (1) removed the President from the Council and its chairmanship, and replaced him with the Vice

President; (2) reduced its membership to include only, in addition to the Vice President, the Secretaries of State and Defense, the Administrator of NASA, and the chairman of the Atomic Energy Commission (dropping an additional government member and three private scientific members); and (3) located it specifically in the Executive Office.

The first task of the Council was to develop the recommendations to the President that led to his lunar landing decision. It did not develop thereafter "a comprehensive program of aeronautical and space activities," which the Space Act, as amended, included in the list of functions to be performed as the President "may request." Equipped for its task by a staff of about 25 persons with specializations in the technical staff related to branches of aeronautical and space activity, it has performed continuously certain other well recognized functions. Welsh has sought, first, to keep the President informed on space activities, and in doing this he has relied on the cooperation of the operating agencies with his staff to obtain detailed information and studies. He has, as part of this function, presented a weekly report to the President. He has at times participated in the policy discussions in budget preparation. The Council has assisted the President on particular policy problems. For example, at the President's request, it prepared a policy statement on communication satellites. Moreover, the Council has served as a means of "effective cooperation" and "resolving differences" among the agencies, two functions defined for it in the Space Act. It has, for example, followed closely the development of the Defense Department's Manned Orbital Laboratory (MOL) project and the issues of duplication and cooperation between NASA and DOD. The Council itself has discussed these things in several meetings, the top secret nature of some of the features of MOL making it an inappropriate area for discussion of some of the issues at the staff level. Welsh believes that the Council's efforts have facilitated cooperation and developed a more balanced view among the agencies than they otherwise would have had.

Welsh attended meetings of the Aeronautics and Astronautics Coordinating Board, and his staff members attended meetings of its panels. He or his staff also attended some of the meetings of science related committees. The various memos of his that have turned up in files show that he was strongly oriented toward continued development of the nation's space technology and exploration.

<u>The Bureau of the Budget</u>. The Bureau is, in spite of arrangements for other inputs in presidential policy-making, the focal point at which issues are most frequently brought into focus. This is because it is at the center of the continuing flow of papers related to allocative decisions that must be made. The structure in the Bureau for detailed

analysis of NASA's budget requests is an Assistant Division Director and three budget analysts. The assistant director, Donald E. Crabill, has been examining NASA's budget since 1960. His knowledge of space issues is supplemented by that of John D. Young, since 1966 Assistant to the Director of the Bureau, who had served in high-level positions in NASA from 1961-1966. The background of Young and Crabill is that of persons trained for generalist administration, in contrast to the science and technology backgrounds of most of the professional staff in NASA.

The Bureau's stance has been to apply a ceiling to space expenditures without impairing both ongoing programs and such new programs as were accepted by the President. Budget stringency has forced ceilings that were low with relation to NASA's program plans and cost projections. Operating within this constraint, the Bureau has concentrated its attention on programming issues: what programs should be undertaken, whether commitments to these could be deferred, and what amounts of money would sustain these programs. It has had to assume that NASA could accurately project the costs of programs, but has pushed NASA for program justifications both as to content and timing. Thus, on the post-Apollo manned space flight program it has demanded that NASA give understandable content to its program and justify the timing of its initiatives. In this respect it has had a purpose like that of congressional committees, although at closer range and therefore with perhaps more immediate effect in forcing NASA leadership to demand from OMSF clearer statements of objectives, tighter planning, realistic scheduling of flights, and deferment of schedules so as to postpone costs. The Bureau has also, in conjunction with the space council, pressed the consideration of the relationship between DOD and NASA manned space flight programs. These efforts have a cost effect, immediately through deferment of costs and continuously through pressure for tighter planning; but the Bureau's deliberations, except for the AO portion of the budget, are in terms of program justification rather than of cost effectiveness.

The Bureau consequently has been a center through which, first, the President's priorities could be enforced through ceilings imposed on agency expenditures and, second, pressure could be exerted on NASA for less ambitious and more precise and politically justifiable programming.

Other Components in Executive Office Decision-Making. Two other structural components are geared into decision-making at the presidential level. One is the Office of Science and Technology in the Executive Office, a small office under the directorship during the period covered by this study of Dr. Donald F. Hornig, distinguished chemist with academic experience and associations. The other is the President's Science Advisory Committee (PSAC), composed mainly of scientists in the private sector, and with an executive officer assigned from Hornig's staff. Hornig has been the President's personal science adviser. He has been a transmittal line between PSAC and the Executive Office. The assistant division director of BOB for NASA, Donald Crabill, is an ex-officio member of PSAC. Through contact with the committee and with Hornig, through the continuous dialogue of Crabill's staff with the one or two men on Hornig's staff who specialize on space activity, and through the reports of PSAC studies, the views of the scientists on space activities are channeled to the BOB.

This input into Executive Office deliberations is distinct and may be a counterweight against other influences. Hornig and the other scientists have not been entirely committed to the views of the "Establishment" in space (NASA, DOD, the space council, and the supporting majorities in congressional committees) and the directions and means of their participation in decision-making will be examined in further detail in a later section of this chapter.

Other inputs in decision-making may be made by staff of the Bureau of the Budget and other advisers to the chief executive on space activities in such departments and agencies as DOD, the Department of the Interior, the Atomic Energy Commission, the Weather Bureau, and those responsible for communications development. Significant also is the Aeronautics and Astronautics Coordinating Board, composed of agency representatives and chaired jointly by the DOD and NASA representatives. Seamans was for years the co-chairman from NASA. Working under the Board are numerous panels through which the technical staffs of DOD and NASA keep informed on activities in the other agency. The Board serves also as a medium for consultation on related, possibly duplicating, programs in DOD and NASA. At times, as in deliberations between 1966 and 1968 on the relation between the DOD's Titan III-MOL manned space program and NASA programs, these deliberations were supplemented by personal consultation between Webb and Defense Secretary Robert McNamara.

The Continuing Relations between the Agency and Congress

We have seen how the Johnson Amendment and the structure of the space authorizations and appropriations acts allocate decision-making within Congress and between Congress and the agency, the Johnson Amendment enlarging the surveillance role of program committees and the authorization and appropriations acts providing flexibility for operating decisions in the agency. We have seen also the peculiar aspects of agency-congressional relations in manned space flight. It is time now to supplement these descriptions with a look at the general and continuing relations of the agency to Congress.

The Four Committees. The Senate space committee in 1968 had ten Democratic and six Republican members. The first chairman was Senator Lyndon B. Johnson, followed in 1961 by Senator Robert S. Kerr, and in 1963 by Senator Clinton P. Anderson (Dem., New Mexico). The ranking minority member since 1963 has been Senator Margaret Chase Smith (Rep., Maine). Eight of the Democrats and Senator Smith have been members of the committee since it began work in 1959. The presence on the committee of the people named and such additional senators as Richard B. Russell (Dem., Georgia), chairman of the Armed Services committee, Warren G. Magnuson, (Dem., Washington), Chairman of the appropriations committee, and Stuart Symington (Dem., Missouri), have given to the committee a blue-ribbon quality, liaison with appropriations and military affairs committees, and some general familiarity with the kinds of problems presented by technological development. On the other hand, the Senate committee members have other large responsibilities and only a few of them are able to give a major share of their attention to space. Anderson and Smith, and certain senators whose constituencies are space-favored, are included in this small group. One congressional liaison official in NASA has remarked, "The technical competence of the Senate on space is in the staff."

The staff of six professional persons (in 1969) was headed by James J. Gehrig, an engineer, who has been staff director since 1965. Only one other member of the staff has a technical background. Gehrig does not claim competence on technical details for either the committee or the staff. He describes the function of the committee as "shadow management," and sees its influence, while quite substantial, as being exerted through deletion or reduction of programs. He disclaims ability to evaluate costs of accepted projects.

NASA officials regard the Senate committee as being generally favorable to the space program, and particularly emphasize the support of Anderson and Smith. Much of Webb's contact with Anderson was by letter and this correspondence reveals a friendly sharing of judgment on issues. The committee nevertheless shows strong independence in its judgments and a persistent desire to be kept informed prior to commitments by the agency. Thus, it cut out the authorization for the Voyager program (unmanned planetary exploration project) in the 1968 budget. Also, repeatedly in the years prior to that it made it clear that it did not think the time was ripe for any commitment to a manned planetary mission.

The House space committee in 1968 had 31 members, 18 Democrats and 13 Republicans. Overton Brooks (Dem., Louisiana) was chairman from 1959 to 1961, and George P. Miller (Dem., California) has been chairman since 1961. The floor leaders of the two parties--John W. McCormack (Dem., Massachusetts) and Joseph W. Martin Jr. (Rep., Massachusetts)--took membership on the committee when it was formed in 1959. Martin was the ranking Republican member until his defeat for reelection removed him from Congress in 1967; since that time James G. Fulton of Pennsylvania has been ranking Republican. Seven members have been on the committee since its formation: Miller, Teague, Joseph E. Karth (Minnesota), Ken Hechler (West Virginia), Emilio Q. Daddario (Connecticut), J. Edward Roush (Indiana), all Democrats, and Richard H. Fulton (Tennessee). Five others have been members since 1961: John W. Davis (Georgia), William F. Ryan (New York), Democrats; and Charles A. Mosher (Ohio), Richard L. Roudebush (Indiana), and Alphonzo Bell (California), Republicans. Eleven members at times had no other committee assignment, although this was true of only three members who had more than two years' experience on the committee. The members are able to specialize in space work to an extent not possible in the Senate space committee. Further specialization results from the operation of the three subcommittees that parallel the three major program offices of NASA. Teague, Karth, and Hechler--chairmen respectively of the subcommittees on Manned Space Flight, Space Science and Applications, and Advanced Research and Technology--have become very knowledgeable on space policy issues through extended service in their positions. Among the committee members, one, Fulton, can claim on the basis of background and continued study to be a technical expert on space matters; a number of others are highly informed on program developments and issues.

The House space committee is served by a staff of about a dozen professionals, several of whom have technical backgrounds related to space professions. And most of these specialize on special aspects of the space program. Peter A. Gerardi and James E. Wilson were specialists on manned space flight in 1968.

Specialization in congressional positions, paralleling that in NASA offices, results in more thorough analysis of space programs than in any other congressional committee. The paralleling produces also some guardianship and sponsorship of programs affected by subcommittee action. Thus, Teague is an ardent advocate of manned space flight and necessarily the heads of OSSA and OART depend on the chairmen of the subcommittees who review their authorizations for support for their programs. The chairman of the space committee must, therefore, serve as mediator among subcommittees and between these and external congressional pressures.

In general the committee is regarded in NASA as being "space minded" and sympathetic to the agency. There are variations among the members, extending from the ardent and regular support of some members to the exceptional antagonism of Congressman William F. Ryan of New York to large space expenditures. When the White House asked NASA about a response to a Ryan speech, a highly placed NASA official replied by letter that it was next to impossible to dissuade Ryan from his points of view. Fulton, as will appear from the subsequent account, is a special case--confident of his expertness, strong-willed, independent, and having firm views of his own on the desirable course of space policy. There are, of course, many differences of opinion in the committee, and often between the subcommittees, on aspects of space policy.

The Senate and House subcommittees handling space appropriations have a larger responsibility for mediating claims of space and other programs than do the space committees, and hence usually reduce the authorizations. They also are less specialized, for both subcommittees consider appropriations for many independent offices and the Department of Housing and Urban Development. The House subcommittee has some specialization in the delegation to its ten members and has one staff member who is responsible for maintaining files of space data for each subcommittee member. The Senate subcommittee, however, included in the year 1967, 17 of the 26 members of the parent committee, including 6 who were members of the space committee, and additionally 2 other persons drawn from the space committee for assistance on matters relating to aeronautics and space. This overlapping of memberships gives to the appropriations subcommittee an opportunity to rely on the knowledge obtained in Senate space committee hearings.

In partial summary it can be said that at the time this study was made (1968) there were in Congress (31 in the House space committee, 16 in the Senate space committee, 10 in the House appropriations subcommittee, and in the Senate appropriations subcommittee who are not also members of the space committee), and about two dozen staff members (if the space staff of the Legislative Reference Service are included) who had specialized responsibility for space policy. While the concentration on space was exclusive for the staff, most members of the committees had other specialized responsibilities and all were subjected to time-consuming demands on legislative matters generally and from their constituencies. Within the group, leadership was concentrated on 13 people, including the chairman and ranking minority members of 4 committees and 3 subcommittees (with Fulton being ranking member of both the House space committee and its manned space subcommittee). These did not share equally in influence derived from strategic position. Miller and Anderson--by virtue of their chairmanships, the in-family relationship with a President and NASA Administrator of their own party, and the concentrations of their attention--were in formidable positions. So also was Congressman Albert Thomas (Dem., Texas), chairman of the House appropriations subcommittee through 1965, and his successor in that position, Joe L. Evins (Dem., Tennessee). Smith and Fulton had contrasting positions, in spite of the similar party positions. Smith, although inquisitive and sometimes critical, shared a bipartisan leadership for the space program; Fulton fought against the leadership for modifications in the program. On segments of the program Karth, Hechler, and Teague had strategic positions. On our topic--manned space flight--Teague had a commanding position in steering the administration program to favorable committee decision. The leadership positions created opportunities for influencing, if not determining, the action of Congress. Yet other persons, nevertheless, may be important for various reasons in support of a program. Thus, Webb found Senator John Stennis (Dem., Mississippi) an important point of contact, and senators in whose states space expenditures were of large economic importance--such as Stennis and Holland of Florida, who were both members of the Senate space committee--were important sources of support for space activity.

Agency-Committee Relations. The formal record of agency presentations is huge. In 1965, a typical year, the presentation to the four committees on the 1966 appropriation covers 3,344 printed pages for the House space committee, 1,117 for the Senate space committee, 422 for the House appropriations subcommittee, and 101 for the Senate appropriations subcommittee, a total of 4,984 pages. The hearings extended over 33 days in the House space committee, 11 in the Senate space committee, 3 in the House appropriations subcommittee, and 1 in the corresponding Senate subcommittee. Reflected in this activity is a stupendous quantity of work by hundreds of people in NASA, for many of whom it is full-time activity. There is, however, much repetition in the hearings and one staff member remarked that the House space committee was getting tired of the volume of materials presented. Mueller's formal summaries on manned space activities especially are lengthy and repetitious of presentations in other years.

The participation in the formal process of annual presentations is largely official. Agency officials from the Administrator's office, from the major divisions, and frequently from the centers, present the agency's case. Officials from related agencies--Defense, AEC, and agencies in communication, weather and other fields served by NASA--frequently submit written or oral statements. Occasionally, persons from the science community make presentations, as also occasionally do congressmen whose districts are affected by space expenditures. Contractors also sometimes make statements to subcommittees at center or company sites.

The informal and less formal contacts are strongly structured on the agency side. While the main burden of formal presentations at the agency level was carried for years by Seamans, Webb assumed a personal responsibility for gaining the understanding and support of the leaders, particularly Chairmen Anderson and Miller. The Office of Legislative Affairs has served as the center for continuous agency communication with Congress. In addition to the general functions of answering or channeling inquiries from Congress and acting in a service capacity to the agency on congressional matters, it has three persons who are each assigned responsibility for contact with one-third of the members of the House space committee.

Agency liaison is designed, not merely to gain specific approvals, but to avoid tension between committee members and the agency. Tensions on information supply have not been absent from NASA-congressional committee relations. Individually, congressmen want advance notice when contracts or grants are awarded in their districts, so that they may announce these; this the agency has provided, though not with entire satisfaction. A letter from Webb to Miller on September 22, 1967, argued for the one-hour notice that was common for NASA instead of the 48-hour notice Miller had requested. Minority members in the House space committee have been jealous of their rights, including access to information. In the House this has taken the form of demands, expressed sometimes in minority committee reports, for staff aid for minority members. One member of the House space committee staff has provided regular service to Fulton since he became ranking minority member, and a member of Fulton's office staff worked regularly with the committee in 1967 and 1968. But jealousy of the right to information has been voiced also by majority members.

Tensions over information mounted in 1967. The Senate space committee conducted a study of the Apollo 204 accident that occurred at Cape Kennedy in January. In the course of the study and hearings, the committee learned of the existence and content of the in-house "Phillips Report" in 1965. The report, issued from the Apollo program director to the contractor (North American) for the spacecraft, had found many deficiencies in contractor management and had recommended remedial measures. The Senate committee did not allege a causal relationship between the deficiencies revealed and the unfortunate accident, but it did resent the lack of information on the existence of the deficiencies. In a report the committee stated that it believed "it should have been informed on the situation" and urged NASA to "keep the appropriate congressional committees informed on significant problems in its programs." This polite language was supplemented in a separate statement by Senators Edward W. Brooke (Rep., Massachusetts) and Charles H. Percy (Rep., Illinois) alleging "lack of candor" and "curious reticence" of NASA to supply facts to the committee on the Phillips report and demanding that NASA "make a more concerted effort to alert Congress to major problem areas as the space program evolves." Senator Walter F. Mondale (Dem., Minnesota) charged even that NASA and the contractor had "attempted to mislead the committee." He thought that "NASA had an unfortunate habit of swamping Congress with engineering details and starving it for policy and managerial information."11/

Other dissatisfactions within the congressional committees over lack of notification on project changes were revealed in the course of the authorization hearings in the spring of 1967. Hechler was concerned over lapsing of the contract for 260" motor, others over the likely cancellation of a lunar mapping and survey system, and still others on the settlements reached with North American on spacecraft contracts. The result was numerous conferences between NASA officials (Webb, Seamans, Shapley, Mueller, and others), committee members (Anderson, Smith, Teague, Hechler), and committee staff. Senator Anderson in a letter to NASA on May 26, made a specific request that NASA inform the committees on what projects were in trouble, what had been done about them, and what further plans NASA had. The House space committee proposed that the authorization bill include a requirement for NASA to keep the committees "fully and currently informed." Ultimately, agreements on procedure were reached, and the proposed legal requirement was deleted in conference committee.

The concern over information is, of course, often reflective of a jealousy over preserving committee association with NASA in decision-making. A routing slip of April 29, 1963 from one member to another of the NASA Office of Legislative Affairs attributes to Teague a statement that "NASA damn well better not put the budget for '65 together without checking with him." Although this may represent an unusual posture for a subcommittee chairman, jealousy over reprogramming after the budget is passed is constant. Congress has, as has been noted, allowed the agency flexibility in reprogramming use of funds. Webb, himself a former director of BOB, has taken the position that any provision for committee veto of reprogramming would be unconstitutional;12/ yet Congress has provided for formal notice by NASA and committee veto over reprogramming between line items in R&D authorizations. In addition to meeting this requirement, Webb has reported to the committees on other major changes. In recent years the operating plan adopted after the budget was passed has regularly been presented to the space committees in executive sessions and reported to the chairmen of appropriation committees. At times a space committee has requested additional executive committee sessions to hear reports on changes in NASA plans.

11/ U. S. Senate, Committee on Aeronautical and Space Sciences, Apollo 204 Accident, Report No. 956, 90th Cong., 2nd Sess., 1968.

12/ For example, a letter from Webb to Anderson, April 8, 1965.

Webb, referring to formal reprogramming notices, said in a letter to Miller on September 7, 1968 that this is a "sensitive area." He said that the agency had taken every possible precaution to reduce the number and magnitude of changes. "For example, we have only exercised the authority for the fiscal year 1965 action six times, in comparison with the 39 actions taken under the 1963 act." (The reduction was probably possible because the program had been stabilized and much of the facilities constructed.) This did not include figures on changes where formal notification was not legally required, on which sensitivity could also exist.

The sums appropriated often register compromises that have been made in the committees, or victories for those who desire that particular projects be undertaken, continued, or expanded. The case story that is presented later will reveal, for example, how certain decisions within the committees, such as those on the SNAP-8 and the 260" solid fuel motor, are followed by pressure on NASA to see what has occurred. The committees have also been particularly concerned with the Administrative Operations category. Some members have thought they did not know enough about how this money was being used in support of the different program activities. There has been much questioning of NASA officials about reprogramming R&D funds into AO use. The sensitivity on this was revealed, for illustration, in a letter from Karth to Webb on February 22, 1966. Karth stated that planned reprogramming from R&D to AO would "virtually negate the action of Congress" in reducing AO funds in the fiscal year 1966 authorization. He, in the absence of chairman Miller, was asking that the change be deferred until there could be deliberation by the full House space committee.

All in all, it is clear that tensions as well as cooperation exist in the continuously intimate relations between NASA and the space committees--produced, in large part, by the Johnson Amendment.

Influences on Congress. Both within Congress and NASA there is frequent attribution of voting behavior of congressmen to the economic impact of space contracting in their districts. This attribution is made without cynicism but merely as acceptance of political reality. NASA makes annual summaries of grants and prime-contracts to business and nonprofit organizations (chiefly universities) by congressional district and the Office of Legislative Affairs summarizes this separately by members of the House space committee (See Table 1, p. 70.) NASA has had reason, both for its own objectives and because of pressure from Congress and the President, to spread contracts to many districts. Its university grants, as well as its contractor choices and its location and support of centers, has provided opportunities to spread its bounty profusely. One who searches the files sees evidence occasionally of the effect of pressure on the apportionment of money and of frequent intervention of congressmen for grants or contracts in their districts.

Yet the internal procedures of NASA--notably the use, procedures, and significance of Source Evaluation Boards--in decisions on contract awards has tended to preserve the dominance of technical considerations and to insulate the agency process against political considerations, including geographical diversity in contract awards. This procedure, outlined above,[13/] tends to preserve to the Administrator the consideration of the political effect of contracts.

The correlation of congressional behavior on space issues with constituency financial interest would by itself be a subject for a major study. Yet some random comments on the variations in the picture are possible here. Congressmen have presented statements to committees in support of space activity in their districts; they have spoken in the houses in favor of such projects; their votes have reflected constituency interests in contracts. Yet the correlation does not always exist. Senator Smith is a strong supporter of space activity, but Maine is not a center of space expenditures. Congressman Bell once voted to reduce the space budget authorization, even though the space expenditures in his district are larger than for any other district having a representative on the House space committee. Teague is regarded generally as the most vigorous and constant supporter of manned space flight, but the great expenditure for space in his state is outside his district and he has not been regarded as an aspirant for a Senate seat. When von Braun was to speak at Texas A. & M. University in Teague's district, Teague asked von Braun to justify space expenditures to his constituents. The total obligations for space expenditures in 1967, by principal place of performance, amounted to more than $10 million each for only 5 of the 31 districts having representation on the House space committee. For only 3 others it was between $5 and $10 million, and for 12 it was less than $1 million. (See Table 1, p. 70.)

The effects that might be attributable to space expenditures are sometimes difficult to assess. The authors heard statements, for example, that Fulton's advocacy of NERVA could not be explained by constituency interest because expenditures on this project by firms with their principal place of business in his district was minimal, other statements alleging influence on him from the spillover into his district of Westinghouse's space expenditures; and Fulton's own statement that on several recent occasions Westinghouse officials had chaired campaign committees opposing his nomination. Other statements emphasized the complexity or independence of the mind of this important and unusual actor on decisions affecting manned space.

13/ See page 52.

Table 1

OBLIGATIONS ON NASA R&D CONTRACTS

FISCAL YEAR 1967

BY CONGRESSIONAL DISTRICT

(thousands of dollars)

DEMOCRATS	
Miller (Calif., 8)	2,637
Teague (Tex., 6)	690
Karth (Minn., 4)	8,455
Hechler (W. Va., 4)	87
Daddario (Conn., 1)	5,700
Roush (Ind., 5)	38
Davis (Ga., 7)	714
Ryan (N. Y., 20)	347
Downing (Va., 1)	30,028
Waggonner (La., 4)	------
Fuqua (Fla., 2)	1,307
Brown (Calif., 29)	354
Green (Pa., 5)	346
Cabell (Tex., 5)	3,620
Wolff (N. Y. 3)	3,986
Brinkley (Ga., 3)	------
Eckhardt (Tex., 8)	18,353
Tiernan (R.I., 2)	49
SUBTOTAL	76,711

REPUBLICANS	
Fulton (Pa., 27)	9
Mosher (Ohio, 13)	3,133
Roudebush (Ind., 10)	27
Bell (Calif., 28)	273,044
Pelly (Wash., 1)	2,341
Rumsfeld (Ill., 13)	1,625
Gurney (Fla., 5)	217,602
Wydler (N. Y., 4)	483,014
Vander Jagt (Mich. 9)	250
Winn (Kan., 3)	2,470
Pettis (Calif., 33)	256
Lukens (Ohio, 24)	-----
Hunt (N. J., 1)	11,217
SUBTOTAL	994,988

U.S. TOTAL 3,943,466

Note: The sum listed for Congressman Wydler is spent in his district and two others. It was not deemed feasible to allocate obligations among the three districts.

The complexity of factors influencing a congressman are indicated in a letter from Webb to President Kennedy on February 28, 1963, in anticipation of a conference between the President and Congressman Miller, new chairman of the House space committee. Webb related Miller's concern about whether expenditures in the space program would be reduced in his home state (California), but Webb added that Miller felt he was near the end of his term and was "anxious that his vigorous support of this program produce results good for the country. He is anxious that no action or event take him by surprise or be interpreted other than in line with the constructive leadership he is endeavoring to provide."

If one turns from individuals to the general impact of space expenditures on congressional action, he may be impressed more by weaknesses than strengths of special interest inputs into the congressional forum. Scientists were divided about the space program and could be politically ineffective; contractors, though some were supplied opportunities by Mueller's arrangements for direct contact with congressional committeemen, often were more interested in the huge defense budget. Even with respect to space a contractor could have an interest in Air Force hardware production that conflicted with production goals of NASA contractors. (The Titan III was a competitor of the Saturn, the first produced for the military by the Martin-Marietta Company, the latter for NASA by Chrysler, Boeing, Douglas, and other firms.) Teague has lamented the inability to get stronger support for NASA's manned space flight program from contractors. He explained to one of the authors that he urged this need to North American officials and suggested that the company get out a brochure on the advantages of the space program. North American's preparation and wide distribution of such a brochure in turn brought criticism in the Senate space committee.

While undoubtedly constituency interests or absence of such interests were factors of influence in the pluralistic forces constraining the positions of committeemen and other members of Congress, one also will have to look in the case study that follows for other inputs. One must look at the weight of institutional influence and the interests that are represented through these influences. What was the impact of the ongoing operation of the manned space family, NASA top leadership, and the presidency in forging programs for congressional consideration? And what other influences seemed to have weight with Congress? Did program integrity--that is, consistency with accepted objectives and promise of public payoffs--have to be established? What weight did the shortage of resources, and the consequent task of allocation among competing claims, have on the final congressional decisions? While these questions of motivation and influence cannot be answered with precision, they are preeminent for our attention as we look at the end of the case at the maelstrom in which decisions are finally made.

The Structure of Group Participation in Policy Development

NASA's program has been especially dependent upon the participation of three groups: engineers, contractors, and scientists. A brief discussion of the participation of the first two groups, and fuller discussion of that of the third is essential to complete this description of the decision arena.

Participation of engineers is internal in the NASA-contractor structure. The scale of this participation is greatest in the manned space program. The lunar landing mission called essentially for development of technological capability, and this required engineering talent. In the OMSF and its allied contractor structure engineers are dominant, both in numbers and in occupancy of numerous strategic administrative positions (both Mueller as the head of OMSF and Seamans as general manager in the agency had engineering backgrounds). The mission and the staffing for it inevitably have maintained a capability orientation in OMSF and a resistance by it to any diversions or extensions of scientific or utilitarian payoffs that would have impeded the achievement of the primary objective. In turn, OMSF planning for a future manned space program was that of a structure that was dominantly engineering in orientation.

The contractor participation may be viewed also as largely internal. We have noted the steps by Mueller to incorporate the executives of the major contractors into the manned space family and its policy deliberations, and also the practice of the Subcommittee on Manned Space Flight of the House space committee to meet at NASA centers with contractors. In addition, we have noted that operating techniques, such as configuration management, brought contractor personnel and center personnel into consultations and committee deliberations where progress was evaluated and decisions made on operational changes. Moreover, the partnership of contractors and centers in projects is often so close that their interests in the type of programs to be maintained or initiated are concurrent and reinforcing.[14/] A contract for a major kind of hardware, such as the lunar module or a stage of the Saturn V launch vehicle, tends to jell indefinitely the choice of contractor, and to produce permanent collaboration of a contractor with the supervising center. The contractor interest, therefore, is supportive of the interest of the supervising center as it makes its claim on the resources of the agency and its contribution to agency programming for the future.

[14/] See for specific illustration, Chapter IV.

The participation of the science group is much more complex. There are, first, a structure of organizations outside NASA through which the opinions of scientists on space policy can be presented, and second, structures and processes within NASA through which scientists can participate in policy development.

The two major organization vehicles through which science can participate in policy development are the President's Science Advisory Committee (PSAC) and the Space Science Board of the National Academy of Sciences. The PSAC originated in a Science Advisory Committee established by President Truman in 1951 within the Office of Defense Mobilization. In 1957 this group was reconstituted as the President's Science Advisory Committee and was transferred to the White House. At the same time its membership was enlarged from 12 to 17; the majority of its members have been top science men from academia. After its move to the White House, the Committee was able to deal more directly with the President and to wield more authority and knowledge with Pentagon officials and members of Congress. Its function is to advise the President in matters relating to science and technology.

The Committee and its panels have been active in appraisal and criticism of NASA's post-Apollo space programs. Independent, skeptical, prestigious, and presumably representative of scientists' opinion, they have brought to the President and the Congress points of view and specific recommendations at variance with those of NASA and thus contributed to debate in the political forum on the purposes, projects, and costs of NASA's proposals.

The Space Science Board (SSB) of the National Academy of Sciences (NAS) was established as a result of a concern developed during the International Geophysical Year (IGY) of 1957-1958 that a mechanism be made available for obtaining scientific advice in the post-IGY period on all types of space satellite research.[15] Scientists themselves originated the concept of such a board and brought their interest to a number of relevant federal agencies. The Board finally was proposed to the Academy by the Directors of the National Science Foundation, the National Advisory Committee for Aeronautics, and the Department of Defense Advanced Research Projects Agency; it was established in mid-1958. The Academy sees the role of the Board as ". . . to stimulate and aid such research, to evaluate proposed research, to recommend relative priorities for use of space vehicles for scientific purposes, to give scientific aid to . . . /national agencies/, and to represent the Academy in international cooperation in space research." The Board supplements its membership by use of consultants, and extends its operations through several standing committees.

The Board interacts with all national agencies on space matters, but its activities more and more have come to be focused on NASA. From the beginning of the space agency's life, it has sought advice from the Board, and a close working relationship has evolved, with each body allowing for guest attendance at key meetings, such as NASA's major program reviews held throughout the year. At working levels close liaison is provided through the Space Science and Applications Steering Committee, with an extensive subcommittee structure, established by NASA and with which the SSB interacts closely. One of the most significant types of activities is its "summer studies" program, wherein some conferences have been held in cooperation with NASA for the purpose of evaluating needs and planning the nation's space science program in various areas.

NASA has created other boards and committees through which working relationships with scientists could be maintained. Note already has been made of STAC, through which OMSF consults with representatives of the science community. Prominent among OSSA's liaisons with science are the Lunar and Planetary Missions Board (created as a lunar missions board in 1966 and changed to its present title in 1967) and an Astronomy Missions Board (created in

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15/ The facts for the discussion presented here of NASA-Space Science Board relations are taken from Charles M. Atkins, NASA and the Space Science Board of the National Academy of Sciences (A Comment Draft), NASA Historical Note, September 1966.

1967). These are advisory boards of scientists or scientists and engineers. They have been active in making recommendations to NASA and are evidence of NASA's strong efforts to provide scientists with the participation that a research report in April 1967 found was lacking among many of them.16/ NASA additionally has established various committees, on an ad hoc or continuing basis, for consultation and advice.

Through use of the cooperative committee structure and other means NASA has sought to integrate science participation into its internal structure and processes. This integration can be seen in two phases of planning with the OSSA:17/ mission definition and payload (experiment) selection.

The OSSA operates through the mechanism of the Space Sciences and Applications Steering Committee. The SSASC is composed of the OSSA associate administrator, his deputy administrator, the deputy associate administrator for engineering, the deputy associate administrator for science (who is chairman), and the heads or deputy administrators of each of OSSA's technical divisions: physics and astronomy, lunar explorations, planetary explorations, bioscience, and space applications. There are discipline-oriented subcommittees reporting to SSASC in such areas as solar physics, astronomy, planetology, planetary atmospheres, planetary biology, space biology, etc., and applications subcommittees for communications, geodesy and cartography, meteorology, navigation, and earth resources survey. The subcommittee chairmen and secretaries are OSSA scientists and other members are appointed with the approval of the OSSA associate administrator or his deputy. The subcommittees are composed of scientists from universities, NASA centers, government laboratories, and industrial and nonprofit research organizations. As noted above, the SSASC works closely with the Space Science Board of the National Academy of Sciences, and SSB staff sit as either members or observers on the subcommittees. The SSASC serves as an interdisciplinary clearing house for the exchange of information and opinion and is the chief center of the decision process relative to space flight investigations.

16/ See L. Vaughn Blankenship, NASA: The Scientific Image, Internal Working Paper No. 65 (a research report supported in part by NASA under Grant #NSG-243 to the University of California), April 1967.

17/ Processes of collaboration exist also in OART, but those within OSSA are analyzed here because of their significance in the story of manned space policy development told in this book.

Planning at the mission definition level involves lead times of from five to ten years and commitments of from several million to a half-billion dollars. Hence factors other than scientific criteria come into play and the decisions take place within the OSSA "live organization" and at higher levels. The dynamics of mission planning is illustrated in the following chart (see Chart V, page 77).

As is implied by this diagram, mission planning involves both informal and formal review by members of the science community and agency representatives, and both scientific and extra-scientific factors come into the considerations. From the division level up, evaluation of resources levels is present, but at the associate administrator level the additional factors of potential congressional approval, attitudes of the Space Science Board of NAS, PSAC, and eminent scientists on the overall NASA program become critical, and face-to-face communication of opinion is the mode. Beyond this, if the concept is a large one, inter-office competition in NASA and the President's own wishes can affect the decision. Hence it would seem clear that the "progress of science" at this level is heavily influenced by the authority of top-level administrative-political decision-makers.

This same point holds, in an even more concrete fashion, for the other, more specific, level of space science decisions--experiment or payload selection. In this phase, scientists have individual career interests at stake, plus professional scientific concerns about the role their experiments can play in advancing scientific knowledge. The overview of the decision process can be presented best in chart form (see Chart VI, page 78).

As the chart indicates, the payload selection process depends upon the initiatives of scientists for proposals and engages scientists in the deliberative process, even more extensively than in mission definition.

Ordinarily, the subcommittee chairmen and secretaries, who are NASA staff people, simply play a coordinative role. However, the chairman can vote in case of a tie, and the secretary possesses an ordinary vote, so that the two NASA personnel can heavily affect the subcommittee's decisions. Yet, in this process also, the final decision is made by NASA officials, and administrative and political factors may be brought into consideration.

Participation in this rather complicated process of decision may involve a substantial investment of time and funds on the part of the scientist proposing experiments, and in addition, he must submit his work to a very broadly based priority system with determinants of

CHART V

THE SPACE SCIENCE MISSION DEFINITION PROCESS

Impetus	Source of Articulation	Typical Steps
1. Scientific Discovery	1. NASA Field Center (Goddard, JPL, etc.)	1. Mission Study Request Directly or Indirectly from NASA Center to NASA Headquarters (Funding)
2. Engineering Need	2. NASA Headquarters (And/or SSASC Subcommittees)	2. Formal Mission Proposal to Appropriate Headquarters Division in OSSA
3. Operational Requirement	3. Missions Boards	3. Review by Division Staff and SSSC Subcommittee
	4. NASA Sponsored Advisory Groups	4. OSSA Associate Administrator's Staff Study
	5. Academic Community	5. Final Decision by OSSA Associate Administrator
	6. Industry Community	6. Project Approval Document from OSSA to Deputy Administrator
	7. Other Government Agencies	
	8. Individual Scientist	
	9. Corporate Planning Group	
	10. NAS Study Groups	

CHART VI

THE SPACE SCIENCE EXPERIMENT SELECTION PROCESS

Step 1

Project Approval from White House and Congress

Step 2

Published Announcement of Opportunity to Participate in Space Flight Investigations (Includes mission parameters)

Step 3

Proposals to OSSA from Potential Experimenters

Step 4

OSSA Program Manager sends Proposals to Appropriate Subcommittee of SSASC

Step 5

SSASC Subcommittee Ranks in Four Groups
- I. Recommended for Flight
- II. Recommended but not Highly Interesting
- III. Good but Underdeveloped
- IV. Not Appropriate

Step 6

OSSA Program Manager Sends Category I, Most of II's, and some III's to field center for engineering Compatibility Assessment

Step 7

Headquarters Meetings with Consultants on Payload and "Experimenters Meeting" for oral presentation by proposing Scientists

Step 8

Headquarters Meeting of Program and Project Managers, and SSASC subcommittee chairmen for tentative decision on payload

Step 9

"Final" Recommendation by SSASC in all-NASA Session Yields Recommendation to Associate Administrator, OSSA

Step 10

Decision by Associate Administrator, OSSA judgment that he in many cases will not share. These points are illustrated most strikingly in the case of science carried out in manned space flight. Here, the process reviewed above is added to by the problems of integration of scientific and man-oriented systems into a single mission, as is shown generally in the following chart (see Chart VII, page 80).

The main point illustrated in the chart is the dominant role played by the Manned Space Flight Experiments Board. This board is made up of the associate administrators from NASA's four main offices (with the OMSF head as chairman), the Director of Advanced Missions, Director of Space Medicine, the field center directors, and a representative from the Department of Defense. The board evaluates experiments twice--once before study of the feasibility of integrating the experiments with the flight mission, and again before the commitment of development funds. A strong figure on the board is the OMSF Associate Administrator in his role as chairman, and his function is to relate the priorities in OSSA's experiment selection to the flight mission, to insure that it is technically feasible to carry the experiment of the flight without impairment of the primary objectives for the flight.

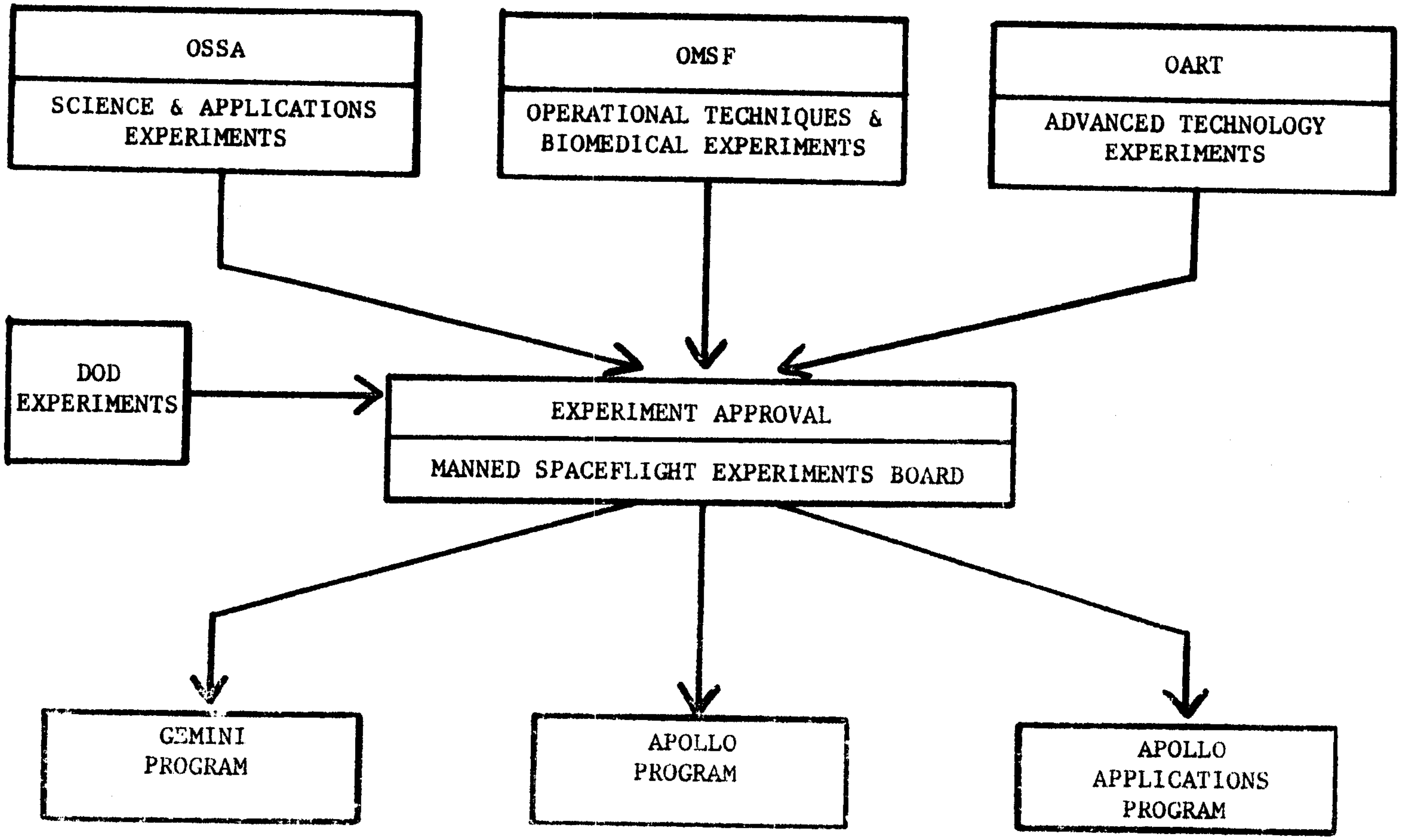
It is apparent that incompatibilities between the objectives of scientists and the mission objectives in manned space flight can create frustrations and disappointments for scientists. The proposing scientist not only may lose the investment of a substantial amount of personal resources in NASA's experiments development decision process; he also may suffer a professional slight to some degree in a rejection of his experiment. Most importantly, he may see this as happening for reasons, he has some basis to suspect, that are not "scientific"--such as intra-agency competition, overhead executive policy, or even how well the experiment will look when discussed before a congressional committee.

In addition, even when successful in surviving the decision process, a scientist may find that, at a critical point in his career, where he has only a few years to research, publish, and establish himself in his profession, his whole career fate hinges on NASA's progress in developing and implementing programs. He may spend all of his research time for a few years supervising, at disparate geographical points in the country, the manufacture of the hardware for his space experiment, only to have the mission cancelled by the agency, aborted in flight, or in the case of a manned mission, go unutilized because of an unexpected contingency that demands a change in mission plans.

<u>Conclusion</u>. Thus, while NASA and the science community need each other and NASA's processes provide for the participation of scientists in the space program through the gamut from policy advice to experiments planning, the possibilities of conflict are inherent in a process where

CHART VII

MSF EXPERIMENT PROGRAM



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scientists, both as policy proponents and as supplicants for space flights, move into an arena where choices among policies and experiments are determined under political and administrative constraints. The potentialities for conflict are increased when mission choices emphasize the development of technological capability, as has been true in manned space programming.

Conclusions

Conclusions derivable from the foregoing analysis that are relevant to the case study that follows in later chapters are these:

1. NASA's organization--in response to program diversification, technicality of operations, and specialization of activities--exemplifies the complexity characteristic of large governmental agencies. The factors that have led to organizational complexity also have produced problems of coordination, conflicts and tensions within the organization, and a difficult task of planning coherently toward defined objectives.

2. A quasi-bureau type of organization, in which planning and coordination for different types of programs were concentrated at the division level, was established after the lunar landing decision. This resulted in strong divisions below the top echelon. It also aggregated great strength in one "bureau" (OMSF) and produced an imbalance of power among the bureaus (divisions).

3. Operating and review procedures were adapted to project management timed by schedule. Management engineering provided tools for integration of progress on thousands of tasks assigned to centers and numerous contractors. Monthly program reviews became the regular means of coordination and review at successive levels, extending upward to NASA's general manager. Highly developed techniques of project management and program review focused attention on operating problems and made possible numerous decisions, continuously over time and adaptive to change, for attainment of specific objectives.

4. Phased project planning, accompanied by vast freedom within NASA and even within its divisions and centers in use of funds, has provided opportunity to initiate numerous technical studies, sometimes competitive and duplicative, and to maintain capability for project progression at future dates.

5. Top management oversight and planning was made difficult by the bureau type of organization and by the engrossment of top

management in project supervision and review of division programs separately. To strengthen oversight and planning at the agency level a countervailing line of oversight and control through an administrative division and a new cross-divisional planning structure, with participation reaching downward to specialists in different divisions, was created in 1967. The new structure and process were conceptualized as countervailing power, agency-wide planning, and participative management.

6. The bureau type of organization was paralleled in the subcommittee structure of the most active center of congressional oversight--the House space committee. This led to continuing political liaison at a level beneath the agency-committee level.

7. Participants in the manned space program have been drawn together in a manned space flight family composed of interacting NASA headquarters and center officials, the principal Saturn/Apollo contractors, representatives of the science community, and the manned space flight subcommittee of the House space committee. This forms a kind of political subsystem favorable to manned space flight program maintenance or expansion.

8. The macro-political level--that is, the presidency and the Congress--is more highly structured for continuous oversight and review of space programs than is characteristic for many other government programs. This is a result, first, of the provision for inputs at the White House from the National Aeronautics and Space Council, the President's Space Advisory Committee, and the Office of Science and Technology; second, of the Johnson Amendment, which has led to annual program authorizations; and third, of the subcommittee structure in the House space committee.

9. The balance between Congress and the agency in program planning and development has been affected by the Johnson Amendment, which has resulted in increased oversight by congressional space committees through annual program reviews, and conversely by the form of the authorization and appropriation acts, which delegate--subject to some reporting to congressional committees--much discretion to the agency in the use of funds.

10. Groups whose competence is essential for the space program--engineers, contractors, and scientists--have been internal participants in its development. Scientists have been offered participation through numerous channels, both external and internal to NASA, yet within a framework of officially determined political and administrative constraints not always concordant with their objectives.

CHAPTER III

THE BACKGROUND OF CONTEXTUAL FACTORS IN POST-APOLLO PLANNING: SITUATIONAL, ENVIRONMENTAL, AND PERCEPTUAL ELEMENTS

We have just completed in Chapter II a description of the several elements that were found in the decision arena within which decisions about the post-Apollo manned space program were taken. The detail and range of this picture, even though it was drawn in overview, indicate the great complexity of the factors that interact to produce decisions on government policy. Still more detail, range, and complexity will be shown as we review here the other elements that were set out at the conclusion of Chapter I as bearing significantly on a given decision situation. In addition, however, we will begin to see the role that history, chance, and some subtle human factors can play in producing policy.

Three types of "contextual factors" that shape decisions were set out in Chapter I: "situational," "environmental," and "perceptual." The role of the situational elements of caprice and serendipity will be illuminated mainly as the narrative of the events of the case history is presented, as when the <u>sequence</u> of certain major events (a situational factor) like the 204 fire is shown to have a significant impact on the development of policy. This is much the case with the environmental factors (resources, technological base, and time frame) as the fluctuations in the resource base and the time frame of the manned post-Apollo program also are shown to some extent in the context of the case history of the events. The facts of the case reveal much less about the nature of the perceptual factors (the ways men viewed events and purpose) that influenced the decisions. These are seen best in retrospect, back where they were formed.

A major purpose of this chapter is to compensate for the uneven visibility in the case of the contextual factors, just as the preceding chapter supplemented the case history by presenting detail that is not brought out fully by the case narrative. Three broad areas will be covered here; for the most part the discussion of these will illuminate the formation of the perceptual context (especially the uncertainties and confusions in this context) that surrounded the actual planning of post-Apollo. The first of the broad areas to be described is the policy background or "program base." Here much of the foundation of the policy "images" that came to bear on the decisions involved in the case will be illuminated. Certain environmental influences, such as the amount and nature of administrative resources, the precedent technological development, and the time frame within which manned post-Apollo decisions were taken, also can be seen in the program base.

Situational factors set by historical background are shown in a second section dealing with a number of major events and decisions most of which occurred well before post-Apollo planning but which ultimately affected it to a significant extent. This section also will throw some light on the technological base that underlaid the post-Apollo period, particularly on some of the technical images that were formed within the agency early in its history. The specifics of the technical base, that is, the parameters and characteristics of the Apollo hardware, are set out in a concluding section.

The Program Base: Perceptual Uncertainties

The context in which NASA was formed consisted of a complicated set of conflicting objectives and motivations. The general tone of the setting was fixed by Russia's Sputnik launches, especially when it became clear that the Soviets soon were going to orbit a man. The military threat implications of the Russian successes were obscure, but the psychological impact of an "enemy" craft regularly flying over the U.S. at an invulnerable altitude was great and created widespread apprehension in the American public. Reaction to this fear was a basic aspect of the rationale for establishing an accelerated U.S. space program. On the other hand, President Eisenhower was impressed differently, as were many members of Congress. The budget-conscious Eisenhower was told by his closest advisers that there was simply no solid rationale for a military effort in space, that is, that no real threat existed in the Russian program. Eisenhower's idea for the space program was to make it a civilian effort, the purpose of which was exploration for peaceful purposes only.

Another view was that of the National Advisory Committee for Aeronautics, which at this time already was devoting 40-50 percent of its research effort to space-related projects and naturally came to occupy the central position in the establishment of a discrete space program. This venerable research facility of the national government for decades had brought significant practical innovations to the field of aeronautics and the aviation industry. NACA had contributed greatly to the nation's war effort in 1940-1945 and hence also was heavily concerned with the use of technology in the military. It therefore viewed space as involving a capability that would serve a wide variety of domestic, international, and military purposes.

Also present was the military--the Army and the Air Force most immediately, and the Navy indirectly--which all had space or space-related programs in operation. The Army, with its team of German rocket scientists already actively engaged in ballistic missile programs, was hesitant to see a civilian emphasis develop in this field; so, too, was the Air Force, which was interested in manned space flight although with no rationale at this point. (Biomedical unknowns forced even the Air Force to view the space "pilot" as a passive rider in the craft, which they thought should be simply an automated ballistic can that would "go up and come down.")

As a result, the objectives of the space program were mixed and priorities among these unclear. At its initiation and for a short time after, reaction to fears largely psychological in nature set the administering agency and the program along a definite course of action, but with an uncertain purpose beyond that of developing a space capability. Currently, these fears have abated and now the question of purpose, rather than action, looms paramount. Insight into how these conditions were created and how they have persisted in modified form can be gained through an examination of the legislative act setting up the program and of the establishment of NASA as an administrative agency. Such an examination can introduce much of the substance of the agency's history up to and through the planning of the post-Apollo program. Perceptual problems and tendencies that showed up in incipient stages at this point later emerged full blown in the context of post-Apollo, as will be seen later in this study.

The National Aeronautics and Space Act of 1958 and the Establishment of NASA

In the background of America's movement into a large-scale space program is a set of circumstances that had more than the usual impact on events.[1/] One part of this set was the military missile activity that was being carried out prior to 1958. This activity was being pursued rather frantically and along five fronts: the Atlas and Titan ICBM's and the Thor IRBM of the Air Force, the Army's Jupiter IRBM, and the Polaris IRBM being developed by the Navy. For the most part, however, these missile programs were encountering serious development problems and failure after failure was encountered on the test stands. The tactical 200-mile-range Redstone was the only operational missile of any size at this time.

The International Geophysical Year of 1957-1958 provided the basis for other rudimentary space activity, since the United States had decided to include a small earth-orbiting satellite as part of its contribution to this major scientific event. This project, "Vanguard," initially was carried out by a committee of civilian scientists and by the Defense Department's Committee on Special Capabilities; ultimately it was awarded to the Navy's Office of Naval Research, with scientific aspects monitored by the IGY Committee of the National Academy of Sciences. However, funding for the program, as well as its overall priority, was low.

1/ Factual material presented here on the background and establishment of NASA was taken from Chapters 1-3 of Robert L. Rosholt, An Administrative History of NASA, 1958-1963 (Washington, D.C.: U.S. Government Printing Office, 1966).

As mentioned earlier, a program of space-related research at NACA also was going on at this time. Though constituting a significant percentage of NACA's overall program, the money actually being spent on space projects was less than $35 million per year. Further, NACA was participating in only one hardware development-type program--the military-related X-15 Rocket airplane begun in 1954. In sum, in 1957 the space and space-related development programs being conducted in the United States were either meager and of low priority, or were encountering severe technical problems.

Thus, the extreme reaction to Russia's orbiting of Sputnik I in October 1957 and to the November 1957, Sputnik II flight of a half-ton spacecraft carrying a dog was based in part on perception of a lagging and problem-ridden space effort in the United States. In fact, however, it was administrative entanglement and inertia more than technical insufficiency that allowed the Russians to be first in reaching space with a satellite. The Army's German missile team at its Redstone Arsenal in Huntsville, Alabama, had submitted a detailed proposal, "Project Orbiter," for orbiting an earth satellite in 1954, which claimed that the project could be executed shortly with available missile components. The idea was shelved by the Defense Department, but the Von Braun team further developed both the hardware and the concept for the project.2/ When Vanguard failed disastrously to meet the Russian challenge by exploding on the launch stand in December 1957, public attention turned to Von Braun and the "Orbiter" project. Then Secretary of Defense Neil McElroy had ordered the Orbiter project revived in November, and only 84 days later the Von Braun team orbited Explorer I, the first U.S. satellite.3/ This event indicated that the decision to shelve the Von Braun effort and to place the emphasis on the Navy project was responsible for the Russian first. It also indicated to Washington policy-makers aware of this story that our space missile capability was not in so dire a state as public and some congressional opinion viewed it. Hence, in spite of the widespread fear created by the speculation about "military implications" that followed the Sputniks, there was some leeway for a considered look at how a national space effort should be configured.

The Eisenhower administration made use of this leeway in its deliberations over what administrative structure should be set up for the program,

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Wernher Von Braun, "The Redstone, Jupiter, and Juno," in The History of Rocket Technology, ed. Eugene M. Emme (Detroit: Wayne State University Press, 1964), p. 111.

3/

Loyd S. Swenson, Jr., James M. Grimwood, and Charles C. Alexander, This New Ocean--A History of Project Mercury (Washington, D.C.: U.S. Government Printing Office, 1966), p. 29.

but the pressure for a rapid, large-scale response directly to the Russian "military threat" could not be escaped completely. The basic alternatives were: a military program, with expansion and integration of the existing military base in this area; a combined program--civilian or peace-oriented, but with military liaison--under a new agency; or a revamping of NACA into a civilian space-oriented agency. In addition to the momentum of the already established military programs which tended to impel events in that direction, Eisenhower faced vectors of political forces stemming from Congress--some in the form of specific proposals such as that voiced by Senator Clinton Anderson, who introduced legislation allocating the bulk of the space program to the Atomic Energy Commission.

The President, however, moved steadily toward the position of advocating a civilian space program conducted by an uprated version of NACA. After deciding in February 1958 to generate a specific proposal, Eisenhower, with the advice of the President's Science Advisory Committee, the Bureau of the Budget, the President's Special Assistant for Science and Technology, and his Advisory Committee on Government Organization, stamped his approval on such a plan in March 1958. This decision, for a civilian program run by a revised NACA, gave the space program and NASA its initial shape and in important ways determined the nature of its development over the first decade of its history.

NACA was founded in 1915 and launched with an appropriation of $5,000. Its 12 members were appointed by the President and served without compensation. Its mission was to "supervise and direct the scientific study of the problems of flight, with a view to their practical solution, and to determine the problems which should be experimentally attacked, and to discuss their solution and their application to practical questions. . . ." It also was noted in the enabling legislation that "in the event of . . . laboratories . . . being placed under the direction of the committee, . . . /it/ may direct and conduct research in aeronautics in such . . . laboratories." The activities of the Committee quickly expanded and only two years later it opened its first research laboratory at Langley Field near Hampton, Virginia. As World War II approached, a second laboratory, the Ames Aeronautical Laboratory, was opened in the San Francisco area and staffed with Langley personnel. More Langley staff were taken to open the Lewis Flight Propulsion Laboratory in 1942. After contributing greatly to the war effort and expanding in the process, NACA set up a rocket research laboratory in Virginia, as well as a "High Speed Flight Station" in California, in 1945 and 1947 respectively.

NACA's substantive research accomplishments were numerous, and gained the agency tremendous respect as a scientific-technical research enterprise. By providing a free atmosphere for research and protection from outside interferences, it was able to attract excellent personnel and to develop some of the best aeronautical research facilities in the world. The chief distinguishing characteristic of the agency was the fact that its own personnel conducted almost all of its research in its own facilities, and thus gave it a strong, broad-based "in-house" competence. Because NACA was a purely research and development agency rather than an "operations" type organization, it maintained relationships with a wide variety of users of its research products in the aircraft industry and in the Department of Defense. These relationships were excellent, as were its wide ties to the scientific community, which it maintained through its university research program. Moreover, the agency enjoyed a distinctive amount of respect from Congress for its frugal fiscal management, wherein the agency traditionally sent back to the Treasury a small part of its appropriation each year.

By the time Sputnik I was launched, almost half of NACA's research, as noted earlier, was space related. This fact alone meant that the agency would necessarily figure in development of any response to the Russian feats. In addition, while there was some tension in the agency over the amount of emphasis being given space--as opposed to purely aeronautical--work, the agency itself made a bid for participation in the space program that was by all predictions to be mounted after Sputnik. Hugh Dryden, then head of NACA, determined that a consensus existed among younger NACA personnel that a major move into space was called for, and that the agency might be hurt severely in the march of events if it did not make such a move. Hence, Dryden led the development of a NACA-sponsored plan for organizing the space effort, which was revealed in January 1958. Rather than setting up a new agency, the plan called for cooperation among organizations already extant. NACA would expand its space effort with a new space-research laboratory and would increase its contract research. At the same time, it proposed a greater flight program, although this would be limited to basic research, with flights having military application being under Defense Department authority. The National Science Foundation (NSF) and the National Academy of Sciences (NAS) were to be given the responsibility for planning experiments, and these would be conducted by the private scientific community. Dryden's proposal for organizing the space effort reflected a realization that the space program was by necessity tremendously broad--too broad for one agency in his view; the plan also disclosed a concern to avoid radical changes in NACA's structure and operations.

Eisenhower's plan, on the other hand, was based on a radical departure and an integrative approach that was designed to clearly stamp his concern for peace-oriented uses of space on the program. His advisers noted several liabilities in remaking NACA into a space agency, most notably its low-geared level of operation, conservative fiscal and personnel policies, inexperience in managing contracted work, and lack of readiness to launch the "demonstration" projects needed to offset Russian successes. The group advising the President suggested, however, that these liabilities easily could be overcome if the agency were renamed, geared up, and relations with the Defense Department clearly articulated.

After presidential approval of the preliminary plans for the agency, draft legislation was prepared and sent to Congress on April 2. During the drafting period, the concept for the agency's role became much more comprehensive and forward looking, with a "new agency" rather than "NACA redone" tone to it. The Budget Bureau's recommendation for a single agency head reporting to the President won out and the NACA position, which held that a top board was needed as a buffer to political interference, was given only a token gesture in the establishment of an advisory-capacity National Aeronautics and Space Board (later, "Council"). Eisenhower wrote to DOD and NACA to tell NACA to reorient itself internally toward the new role it would assume, and to communicate with NAS and NSF as to how best to effect and secure the participation of the scientific community. With DOD, NACA was to conduct a program review with an eye to seeing which programs and facilities should be transferred to NASA, and which were military in nature.

Congress, Democrat controlled, was eager to receive the proposed legislation; each house had created a special committee on space and astronautics. The Act was passed only after three months of hearings that began in April, and President Eisenhower signed it into law on July 29, 1958.

Congress met the heavily "civilian-oriented" Administration proposal with a strong concern for the military security aspects of space and the Russian space threat. The major changes it made in the draft legislation reflect this concern. Title I of the Act, the statement of national space policy, stressed that the U.S. program was to benefit the security and welfare of all mankind by pursuing the peaceful objectives of expanded searches for scientific understanding in aeronautical and space-related matters, international cooperation, and coordination of public and private space efforts. This title mandated further that U.S. space leadership should be preserved, and that the program be the responsibility of a civilian agency. However, Congress provided that activities associated with weapons systems, military operations, or "the defense of the United States" were to be conducted by the Defense Department. The President was designated to decide the marginal cases.

Title II of the Act dealt with the coordination of aeronautical and space activities. The National Aeronautics and Space Council, the structure of which was described in Chapter II, among other duties specifically was given the job of advising the President on the development of a coordinated space effort between the military and NASA. There was a clear implication that both the civilian and military emphases in space be kept strong. This title of the Act also established NASA as an agency, with three functions: to "plan, direct, and conduct aeronautical and space activities," to arrange for the participation of the scientific community in these activities, and to widely disseminate information about these activities. In this mandate, NASA was set up as an operating agency as well as a research and development enterprise. In addition, it was given exceptional flexibility and freedom in personnel policy through significant exemptions from the Classification Act of 1949 that would enable it to recruit and keep engineers and scientists. At the initiative of the House, a Civilian-Military Liaison Committee was set up under this title to enable DOD and NASA to advise and consult on program jurisdictional matters; in case of disagreement, the President was to decide. One other notable section under this title cited the need for NASA to cooperate with other nations in its activities.

Miscellaneous matters were dealt with in Title III. Here, NASA was put under internal security provisions, and authorized to make monetary awards for scientific and technical contributions. The space agency was given a patent policy (soon to become quite controversial) to be administered by an agency Inventions and Contributions Board, which could decide when NASA-supported inventions were to be made U.S. property. Under this title also the President was empowered for four years to transfer space-related activities of other agencies to NASA by only informing Congress of the moves; thereafter, such transfers would be subject to a 60-day congressional veto period.

The legislative background of NASA produced three outcomes worthy of special note. The first of these was the decision, made in the executive draft legislation and affirmed by Congress, to head the agency with an administrator; the NACA concept of a top "governing council" was shunted to the sidelines. Second, the agency was given a mandate to carry out space flight operations on a large scale in addition to the research and development functions traditionally performed by NACA. A third significant outcome was the ambiguity left in the agency's mandate about its relation to other agencies. This relationship was specified only so far as to indicate that NASA was to pursue some goals exclusively its own but was to serve other agencies also where appropriate. Apparently it was hoped that time and presidential decision would solve this problem.

When NASA was set in operation as an agency on October 1, 1958, Dryden in NACA had already launched a study, headed by Abe Silverstein at the Lewis Center, of the hardware development problems faced in initiating and conducting a space-flight program. The necessity of integrating DOD programs into NASA's effort quickly became apparent in this study, and talks with DOD followed soon. The biggest problems in locating the various programs then underway concerned manned flight programs. The first solution attempted, soon scotched by the Budget Bureau, was to conduct this program jointly. No firm decisions were taken in this area as the Act was going through Congress. Later, after the first NASA administrator had been appointed, agreement was reached on the projects to be given to NASA. Among those were the IGY satellite project Vanguard, including funds and hardware. A number of items were taken from the Air Force: jurisdiction over two lunar probe projects and several engine development projects. The agency also got two other lunar probe projects, along with three satellite programs, from the Army.

While agreements such as these were reached on project transfers, serious problems were encountered in attempts to transfer related facilities to NASA.[4] This type of problem is best illustrated in the agency's attempt to move under its authority the Army's Jet Propulsion Laboratory at the California Institute of Technology and about half (specifically, the Von Braun team) of its missile capability headquartered at the Redstone Arsenal in Huntsville, Alabama. The Army objected strenuously, and carried its fight into the political arena. The issue initially was resolved in the National Aeronautics and Space Council, where JPL was given to NASA but the Von Braun team kept with the Army. NASA did not accept this decision as final, however, and as subsequent events unfolded, it was reversed. The Von Braun team's main effort was on Saturn, a large booster concept that in 1958-1959 appeared to have little or no military application. Since NASA could argue a need for such booster capability, the team and its project were transferred formally to the agency in March 1960 as the Marshall Space Flight Center.

When the Manned Spacecraft Center in Houston, Texas, began operations in temporary quarters in 1962, NASA essentially had assumed its full posture as a large operating agency. The metamorphosis from NACA, one of the landmarks of which was the acquisition of the Von Braun rocket team, was complete.

Contextual Factors Arising from the Birth Period

This background view of the program base with which NASA began its life provides a start to an understanding of the perceptual uncertainty that has led in turn to some development problems for the agency. The decision to build the organizational structure of the program around NACA, yet both to gear the program up and to add an operations capability to the research and development capacity NACA possessed, caused some birth and growth pains. For example, an outsider, T. Keith Glennan, was appointed as NASA's chief and Dryden's superior in the new agency. This move seemed necessary to insure that a new perspective would be brought to the old structure. (Dryden was not chosen, it is important to note, because of his frankly conservative attitudes toward fiscal management in research enterprises.) The uprating also involved the development of an all-

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4/ See Chapter II, pages 39-40, for a summary of facilities transfers.

important contract management capability which NACA did not possess. Further, bringing NACA research teams into interfaces with the newly created headquarters organizational elements as well as with established elements of different backgrounds, such as the Von Braun team, further complicated matters. Last, the frictions and difficulties of making formal project and facilities transfers from the various military agencies used up the hard-won credit that NACA had earned in its long years of diligent cooperation with defense agencies. The military was left as a potential competitor for program funds and political support, and this ultimately would increase NASA's difficulty in rationalizing its manned space program.

These structural issues can be seen as manifestations of perceptual confusion, not clearly settled by the Act, about just what position space should occupy in the national interest. The birth period failed to yield a political image by which space could be perceived in the context of competing policy concerns; the complex set of objectives stated in the Act--including expansion of knowledge, improvement in technology, national defense, and utilization of space activities for peaceful and scientific purposes--shows this plainly. Without such an image, for example, what relationship the space capability actually had to national defense could not be seen. The public and much of Congress saw the answer one way, the Administration saw it another. What the NASA Act of 1958 lacked was a statement of policy that would have resolved this question and the questions created by the combination of research activity and manufacturing capability created by the conversion of NACA into the expanded NASA. As is often the case with new agencies, the first administrator saw one of his greatest frustrations as the "absence of a clear national space policy" and guidelines for action.5/ This frustration was in considerable degree obscured by the decision taken in 1961 to land a man on the moon by 1970, which event was so monumental in scope and magnitude that it glossed over the central issues of "national policy." The problem of the lack of a firm perceptual context, however, inevitably rose even closer to the surface when a post-Apollo manned space program was considered. Also, the organizational pattern specifically oriented toward the achievement of the lunar landing goal would materially affect, as the preceding chapter showed, the agency's approaches in policy planning and its ability to develop a post-Apollo program.

In general, however, the problems that will be seen in the post-Apollo planning episode go back to the fact that space flight capability posed a novel and particularly difficult conceptual problem for the American political system. Policy-makers primarily were faced with the task of conceiving a purpose for the new capability. This differed from their traditional job of having to start with a perceived problem and

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5/ Rosholt, p. 41.

link an appropriate technical capability to it (although an "apparent" problem, the Russian space flight capability, did exist and did demand some reaction). As noted in Chapter I, this combination of the tasks of setting purposes for and meeting problems with new technical capabilities is a distinctive aspect of space policy, and makes it an excellent case for analyzing the policy-making problems that this political system will face as it moves through the transition of current history and into the future. It seems apparent that the problem of setting purposes for capability will become more and more the typical task of politics and administration as the United States moves beyond industrialism. The outcome of NASA's birth period shows how difficult is the formation of firm perceptual images that define purposes and relate capability to them.

Background Decisions, Events, and Issues

Beginning of an Image: NASA's 1960 and 1963 Manned Space Flight Long-Range Plan

The conceptual foundation laid in the establishment of NASA failed to yield a clear and certain political image for it, and early planning efforts failed to fix it in a firm and legitimated administrative policy image. The primary reason for the lack of legitimacy of the early planning efforts was that the press of events in the immediate "operations" aspect of the agency overwhelmed efforts to develop long-range thinking on a broad participatory basis throughout the agency. The many and unexpected problems that demanded solution if current programs like Mercury were to be successful made planning for the future seem, at best, somewhat off the point. This attitude was strongest among operations personnel, who had the expertise that was needed for a meaningful planning effort. As a result, the few plans that were developed, such as the 1960 plan, were mainly speculative in nature and generally represented the thinking of those directly responsible for drafting plans. With little participation outside the planning effort itself, the plans generated in the early days of the agency's life normally were discounted for being too narrowly based--by agency personnel. This soon led to an abandonment of the long-range planning effort.

As problematic as NASA's early efforts at planning were, a number of concepts and program premises emerged in the area of manned space flight that persisted in the agency's thinking through the 1960's. The basic philosophy for the NASA mission in this area was stated in the 1960 long-range plan and emphasized the development of a "capability" for manned flight. The plan noted that the substantive purpose for this capability was necessarily unspecified in that the "benefits. . . are in large measure, unknown." The emphasis, therefore, was on the exercise of engineering skill for the development of a technology. As the plan put it, "We should therefore state only one broad objective for the manned space flight program: To provide the capability for manned exploration of space."

Given the state of the art of space flight in the late fifties, the specific program objectives conceived to go with this goal were strikingly bold. Lunar and planetary landings by men were both specified, as well as the goal of establishing a manned space station in earth orbit. This orbiting laboratory, and the more dramatic mission of a circumlunar flight, were planned to occur within the 1960's. These objectives and the time frame in which they were set are shown on Chart VIII.

The plan also was bold in the extent to which it specified the pattern that was to be followed in spacecraft hardware development. The development of an advanced spacecraft was set as a "next step," and the craft was to be designed so as to permit flexibility in use: a laboratory for earth orbit as well as for lunar missions. The basic principle to be followed in spacecraft development was set as the "modular concept." Under this concept a "spacecraft" would consist of modules, each employed for different phases of a mission. These were called the "command center module," the "propulsion module" (for aborts, translunar and lunar orbit insertions, earth return, etc.), and a "mission module," which was a part of the craft to be designed specifically for whatever mission was to be flown. It would house the crew during the mission, but would be abandoned in orbit as the crew returned to earth in the command center module. Chart IX, taken from the plan itself, elaborates this concept.

The development of greater booster capacity was seen as the pacing item determining the specification of mission objectives for the short term; this was the reason stated for opting for the circumlunar flight as opposed to a manned landing for the 1960's. There appeared to be little apprehension that development or mission obstacles of a technical nature would interfere with the planned programs, however. The only major concerns evidenced were in the area of human factors: biomedical unknowns were prevalent at this point in the form of such matters as zero and multiple G forces, and there was serious apprehension about the radiation hazard on lunar and planetary missions, especially from solar flares, and about the shielding requirements this problem might impose on the craft.

The plan was very explicit in stating funding requirements and projections, and, most significantly, indicated that program spending would rise steadily until 1966 (to the figure of $350 million for manned flight) and then level off for the future at the same point.

CHART VIII

MANNED SPACEFLIGHT PROGRAM

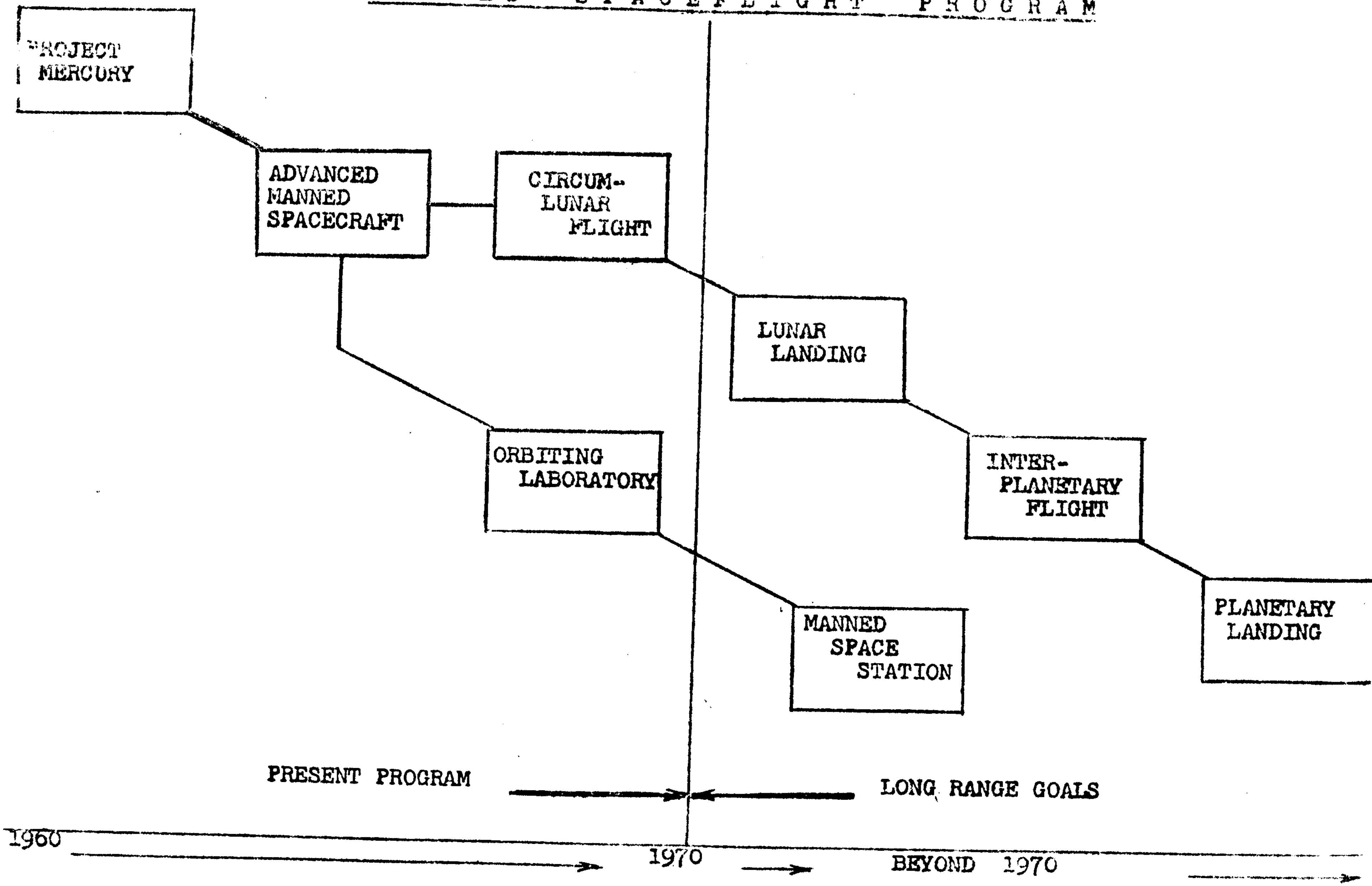
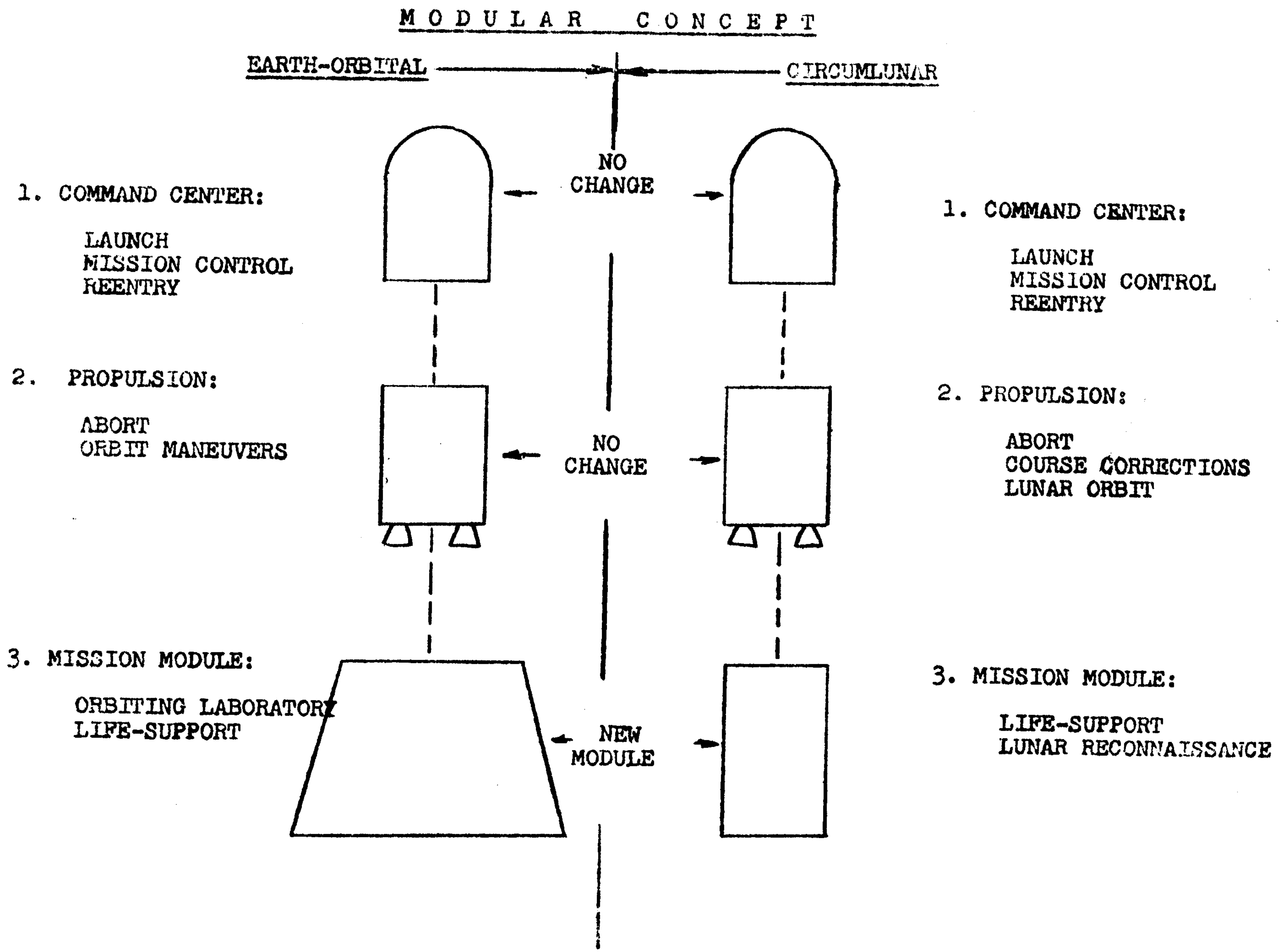


CHART IX


MODULAR CONCEPT
EARTH-ORBITAL
CIRCUMLUNAR
1. COMMAND CENTER:
LAUNCH
MISSION CONTROL
REENTRY
NO CHANGE
1. COMMAND CENTER:
LAUNCH
MISSION CONTROL
REENTRY
2. PROPULSION:
ABORT
ORBIT MANEUVERS
NO CHANGE
2. PROPULSION:
ABORT
COURSE CORRECTIONS
LUNAR ORBIT
3. MISSION MODULE:
ORBITING LABORATORY
LIFE-SUPPORT
NEW MODULE
3. MISSION MODULE:
LIFE-SUPPORT
LUNAR RECONNAISSANCE

In sum, except for the low funding estimate, the plan could be characterized as rather explicitly grand. It also was optimistic and showed a firm confidence about the development of the space flight technology that would be needed for carrying out its large and dramatic objectives.

This confidence was displayed when the Office of Manned Space Flight framed a "Long Range Plan 1963-1975." There was much evidence of the enthusiasm and momentum given the space effort by the President's endorsement of the manned lunar landing program and of the emerging centrality of space to the national interest that his backing reflected. The specifics of the plan showed this clearly; it set out four major program areas to be pursued, from the manned lunar landing, through manned lunar exploration, through manned space stations, to manned planetary explorations.

The manned lunar landing program now included project Gemini as an interim to Mercury and Apollo, with completion of the Gemini spacecraft projected for 1964. A manned Saturn 1 flight for Apollo and an R&D Saturn I flight were scheduled for 1966. The lunar landing itself was scheduled to occur in 1967 with the LOR mode.

Three phases were projected for manned lunar exploration following the lunar landing. The first was a data acquisition and preliminary development period to be carried out during the Apollo series of lunar landings supplemented with the "Lunar Logistics System" urged in the lunar landing mode study by Von Braun. The second phase was the establishment of temporary lunar base facilities with stay times of three months and the development of a lunar surface roving capability for site selection of a permanent base. The third phase was scheduled for 1973-1975 and projected the setting up of semi-permanent bases on the lunar surface to be operational by 1975.

The manned space station program was set out in two phases. In phase one an essential preliminary development step was seen to be the use in earth orbit of several Apollo spacecraft, with extended life support and stabilization capacity, to carry out zero gravity experiments of one to three months duration. Such experimentation was seen as essential to answering by 1966 the question of whether or not future craft could be designed for zero-G or for artificial gravity, since one of the critical "unknowns" of such missions was whether or not man could exist unharmed for extended periods in a zero-G environment. Following these flights but still within phase one, developmental launches of a modified Apollo resupply craft were projected for mid-1966 to mid-1967. After these launches, it was projected that a first space station of 3,000 to 5,000 cubic feet volume weighing 25,000 to 100,000 pounds and with a crew of four to six members could be flown in 1967. Crew rotation and supply were scheduled for one to three months. An upgraded station, if needed, could be launched in the latter part of 1968.

Phase two of the program would not be sequential, but rather would overlap with phase one beginning in 1966 at the conclusion of the zero-G experiments. This phase projected large Saturn V-launched space stations by mid-1969 that would provide stay times of one year in orbit for the crew. Crews would be made up of twelve members, both scientists and astronauts, to be recycled every four months, with an additional six members left up for a one-year period. A second such station was scheduled for polar orbit by late 1970, to be followed by another in 1973. A 1972 launch of a large advanced space station into low inclination orbit would serve as a semipermanent staging base for planetary missions; this station would be manned by a crew of twenty-four. A new set of ground facilities would be required for polar orbit operations.

The interplanetary missions plan focused on Mars with a dual cargo- and crew-ship configuration to be launched for Mars orbit or landing in 1975. Such missions would require NOVA boosters, 600-ton spacecraft, and the development of earth orbit rendezvous operations for piecing the planetary ship together. New problems in life support systems and radiation hazards were expected, but the plan exuded confidence that these would be overcome.

In sum, while the 1960 plan for manned space flight programs was grand, the 1963 plan was colossal.

Events Confirm the Perceptual Factor: The 1961 Manned Lunar Landing Decision[6]

The scope and tone of the 1960 plan was especially striking in light of the general context within which the agency was operating at the start of the 1960's. Skepticism and criticism of the agency and its manned space flight program were both prevalent and intense as costs on the Mercury program soared beyond all expectations, and persistent failures caused schedules to slip. This criticism was felt most strongly when, in the preparation of the budget for the 1962 fiscal year, President Eisenhower cut $240 million dollars of the agency's requested $1.35 billion and specifically removed all funds for further manned space flight programs beyond Mercury. As noted earlier, little substance, except that of psychological demonstration, ever had been seen in the manned flight program by Eisenhower; he was actively detracting from the NASA effort, so that little hope for the future could be seen by the agency. Many officials were frankly doubtful about its continued existence in the form originally planned for it.

6/

The facts presented here regarding the manned lunar landing decision are taken from John M. Logsdon, The Decision to Go to the Moon: Project Apollo and the National Interest (Cambridge, Mass.: M.I.T. Press, 1970). Also, cf. E. M. Emme, "Historical Perspectives on Apollo," Journal of Spacecraft and Rockets, V, No. 4 (April 1968), 369-82.

This mood was given ominous force by a task group appointed by incoming President Kennedy to study space policy. The group, headed by MIT scientist Jerome Wiesner, reported in a heavily critical vein to Kennedy about NASA, as well as about the space programs going on in the Department of Defense. The group told Kennedy that NASA management lacked vigor, imagination, and technical competence, and that the manned flight program was especially dubious: it called Mercury a "marginal" program that should not be continued unchanged and that the President should not endorse. The only favorable words in the report were for the space science program, and the group deplored the imbalance of priorities given the manned program over the agency's space science effort.

While Kennedy had used the "space race lag" very effectively in his presidential campaign, space was the area in which he and most of his advisers were least informed. This was reflected in his early statements as President about space in that virtually his only point was to urge cooperation between Russia and the U.S. in space exploration.

Kennedy's first confrontation with space policy came in a meeting between him, Vice-President Lyndon Johnson, and top NASA officials on March 22, 1961. NASA at that point was seeking approval of Project Apollo, eliminated by Eisenhower. Remarkably, in one part of the presentation to the President the agency representatives proposed a lunar landing by 1970. Kennedy, however, proceeded with an air of calm if not caution, and reserved decision. He did decide to support an acceleration of the booster program, but he approved none of the requested funds for Apollo or for unmanned lunar and planetary flights that were the prelude to manned lunar flights. A key premise in Kennedy's action was the fact that no manned Mercury flights, even sub-orbital, had been flown yet.

The air of "wait-and-see" and the Administration's calm moves toward reorganization and increased coordination of space efforts were soon overshadowed by the course and sequence of events, however. As the U.S. space team worked to try a manned sub-orbital launch in late April with the Redstone booster, now man-rated (i.e., safe for manned flight) but with a projected reliability of only a 70-85 percent reliability coefficient, a Moscow dispatch announced that Major Yuri Alekseyevich Gagarin had orbited the earth in the world's first space ship on April 12. The Russians quickly capitalized on the propaganda value of the flight, and with enormous effectiveness. No American official had predicted the flight and prepared the public for it; hence, the reaction in the U.S. was almost as extreme as had been the impact of Sputnik.

In Congress, hearings were held in the House in an air of hysteria that produced talk of wartime mobilization and a "full scale congressional investigation." Ironically, NASA, then before Congress in authorization hearings, was saying that there were no plans to request funds for the Apollo project. The mood in Congress was one of urgency and action; but Kennedy remained cautious and simply asked again for cooperation in space exploration with Russia. He was moving steadily toward the position of support for a major space effort, but in a considered fashion.

Events continued to intervene, however. The Bay of Pigs invasion, which began on April 15, clearly had become a disaster within four days. Kennedy was depressed by this fiasco and recognized that his presidential image had been damaged severely. The Bay of Pigs disaster helped set a context for presidential decision-making that cast the Apollo program into a light of even increased urgency and importance.

Through Vice-President Johnson, acting as head of the Space Council, Kennedy addressed the questions of what emphasis the space program ought to be given and whether or not the U.S. could hope to beat the Russians to a space spectacular. Analysis showed that on a manned lunar landing the U.S. had at least an even chance of beating the Russians. Support for this objective seemed widespread, and after delays, the Mercury program was launched on May 5 with the successful sub-orbital flight of Alan Shepard. Kennedy spontaneously called Shepard to congratulate him, and that afternoon announced that he was going to initiate a "substantially larger effort" in space. On May 25, Kennedy asked Congress in a special address for a decision that the United States should commit itself "before this decade is out" to landing a man on the moon and returning him safely to earth.

With his decision to send men to the moon, Kennedy fixed many important environmental factors that later would impact on agency thinking about the post-Apollo period. For example, as noted in Chapter II, this decision was a major determinant of resources available to the agency. As such, it produced a considerable impact on further decisions, such as that on the landing mode to be examined next, which largely fixed the parameters of the technology available to the agency for post-Apollo.

Mainly, however, the lunar landing decision helped set major perceptual factors. The background out of which the decision was finally broached and made seemed to stamp even more clearly the purpose of the space program as the development of a capability for manned space flight that could be demonstrated as an effective reaction to Russian space feats.

Enter Environmental Factors: The Lunar Landing Mode Decision

The Space Act and the lunar landing decision were important events among the situational factors affecting post-Apollo manned space flight planning. A third event of major significance was the lunar mode decision, which determined the framework for the technical planning of the post-Apollo program. While the event itself is an illustration of situational factors, the technological base established for post-Apollo planning in the decision became an important environmental factor in such planning.

Kennedy's request for a national commitment to send men to the moon was more a point of high drama in a continuing saga than it was an act of initiation. NASA had begun thinking in October 1960 about a manned lunar mission to follow the Mercury program, and some aspects of the task had been begun even much before then. Earlier, in July of 1960, the agency had announced that Project Apollo, then defined as a circum-lunar flight, would be its next manned flight program. This background thinking and development work became tremendously relevant when Kennedy announced the landing decision and thereby placed pressure on NASA for a determination of what mode or overall mission configuration would be used to effect the lunar landing and return, since mode selection was the pacing decision for further technical developments.

Thinking within the agency on the lunar mode question was varied and had shifted over time. Basically the alternatives for the mission were "direct ascent" (DA) of a large, integrated spacecraft-rocket from earth to the moon; "earth orbit rendezvous" (EOR), where a moon craft would be assembled, or by another concept fueled, in earth orbit after dual rocket shots carrying the components up; and "lunar orbit rendezvous" (LOR), a mission concept developed by John Houbolt at the NASA Langley Research Center, where a moon craft would be disengaged from a parent ship in orbit around the moon, land and return to lunar orbit and rendezvous with the parent, which then would return to earth.

The decision concerning which of these modes was best proceeded through a series of committee study efforts beginning in late 1960.7/ The first of these committees was created by George Low, then Program Chief for Manned Space Flight at NASA headquarters. This group established ground rules for the missions, specified weight estimates and vehicle requirements, and prepared an integrated plan. The work of this committee indicated that there was major disagreement within the agency over the question of mission mode. The Space Task Group, headed by John Gilruth and later to become the nucleus of the Manned Spacecraft Center at Houston, favored the DA mode while MSFC was more inclined to EOR. LOR was introduced at numerous meetings at this time but was given little attention. A second Low committee, which met during January 1961 to consider mission mode, costs, and schedules, judged that EOR was the mode offering mission completion in the least amount of time. The committee indicated that the mission could be carried out by 1968 or 1969, and that in case of development difficulty with EOR, the DA large booster mode could be carried out in 1970 or 1971. This group did not mention LOR. A third committee, the "Fleming Committee," created by Seamans in May 1961 and headed by William Fleming of Seamans' office, favored the DA large booster mode and indicated that a manned moon mission using this plan could be carried out by mid-1967.

7/

Facts concerning the history of agency study of the mode decision are taken from John M. Logsdon, NASA's Implementation of the Lunar Landing Decision (Washington, D.C.: National Aeronautics and Space Administration, 1969).

In order to broaden the agency's analysis of the mode question, Seamans then appointed still another committee, charged with assessing a wide variety of mission modes, to be headed by Bruce Lundin of the Lewis Center. This committee met for a week during June 1961 and settled on a clear preference for the EOR approach. Later that same month Seamans created the Heaton Committee, headed by Air Force Colonel Donald Heaton, to establish plans and assess resources necessary for the lunar mission by means of the rendezvous technique. Their major conclusion was that "rendezvous" offered the earliest possibility for mission accomplishment.

As study of the moon landing program deepened and the problem of beating the Russians to the moon came to the fore, Seamans, thinking that effective centralized planning accounted for a large part of the Russian successes in the space race, was led to centralize the planning effort behind the mission. This led to a joint NASA-DOD study effort called the Large Launch Vehicle Planning Group, headed by Nicholas Golovin. This committee left unanswered a large number of critical questions, but it did conclude that LOR or EOR would offer the earliest way of getting a man to the moon and back.

Through 1961 the NASA position on the question of mode selection shifted away from DA to some form of EOR. The LOR option, while in the picture from the outset, had difficulty obtaining a sympathetic hearing. Proponents of this mode, however, persisted in their efforts to gain acceptance for it through the agency. Gradually these efforts, particularly those of John Houbolt at Langley, the proposer of the scheme, had their effect, especially with Gilruth and the Houston Center. While the mode question was in the latter stages of this consideration, however, EOR was designated as the "working mode."

One of the early premises about the mission that somehow developed in the agency and remained fixed was that the crew would consist of three men. The reasoning underlying this premise was held at an intuitive and implicit level. No one seems to recall how this conclusion came about. It "just happened" that a consensus occurred about this notion such that when a two-man-crew concept was proposed, as it was at one point by MSFC in connection with the DA mode, it seemed simply to slip out of the picture. The major argument put forward for the three-man-crew notion was that it offered a better chance of getting back at least one man in case a mission disaster happened, and that it increased the potential capability for a rescue operation. This argument, as shall be seen later, was at best controversial.

Most of the public discussion of the lunar mission took place in the framework of the EOR mode, and an expectation developed that this mode would be used. At the same time, NASA had been giving Kennedy information about the mission based on the assumption of the direct ascent mode. In fact, on July 8, 1962, just days before the lunar mode decision was announced, an article in Parade magazine stated that in the "moon race" the Russians were attempting to win at the risk of their astronauts' lives by employing the "riskier but speedier" LOR mode, while the U.S. would use the sober but more difficult EOR or DA modes.8/

The EOR mode in particular seemed to be the favored approach. Von Braun at Marshall strongly supported this mode, and it was said to be desirable for its future military applications. Many agency people saw Von Braun and the Marshall Center as having a significant stake in the mode selection: with either EOR or DA, Marshall would play a large and central role in Apollo and in later programs, since it was expected that development of an extensive EOR technology would open a large number of "space ship" options for the future that would involve many variations in rocket technology. Some agency people also felt that an emotional stake was involved: that Von Braun and his team wanted the first manned object to land on the moon to be a Huntsville product. The Houston Center, on the other hand, seemed to have a stake in the adoption of LOR as the mission mode. LOR would mean that emphasis on spacecraft development would be given much greater weight, since under this option there would be two manned craft developed, and booster and spacecraft would not be as completely integrated as under the DA and EOR plans.

The divergence in viewpoint between Houston and Huntsville over the mode selection is reflected in a "memo for the record" prepared in mid-January 1962 by Joseph Shea, then head of the Office of Systems Engineering in OMSF.

> Most of the MSC people seem enthusiastic about LOR. However, I don't feel they have a good understanding of the rendezvous problem, and their weight estimates for the LOR operation seem quite optimistic.
>
> Their /Marshall's/ version of EOR is quite different from the MSC version. In essence, each Center has its equipment doing most of the work, and completely ignores the capability hardware.
>
> MSFC has not paid any attention to LOR and was not in a good position to comment on the mode. Their instinctive reaction, however, was negative.9/

8/ "Race to the Moon--How We Can Beat the Russians," Parade, July 8, 1962, pp. 4-5.

9/ Logsdon, NASA's Implementation of the Lunar Landing Decision, p. 51.

The agency's rationale and analysis for its "final" lunar mode decision was stated in the Manned Lunar Landing Program Mode Comparison study, issued by NASA's Office of Manned Space Flight and printed July 30, 1962; the decision was announced earlier, on July 11. Interestingly, this document was given a security classification and was not declassified until 1968. The analysis it contained provided an excellent example of the problems of technical decision-making under the press of time and external considerations. It was a rich illustration of how contextual factors, particularly situational elements and available technological options, could impact on decisions--in this case, directly on the mode decision and, indirectly, on the design of the post-Apollo program.

The document stated that the goals of the lunar program were to land a man on the moon by 1970 and to provide a basis for a "pre-eminent" space capability for the nation. The latter objective included building "the basis for an extended lunar exploration program after the initial landing without requiring major new development programs." Major factors in the mode selection were (1) technical criteria and (2) least disruption of then-current development contracts. As noted above, a good deal of work on the lunar mission already had been carried out by the agency. The Saturn I and advanced Saturn V boosters were under development, as well as work on the command and service modules composing the Apollo spacecraft.

The mode options as defined for the analysis were basically four: (1) EOR with the Saturn V and the then-planned Apollo command module (CM); (2) LOR with the Saturn V, Apollo CM, and a lunar craft; (3) DA with either a liquid super booster (NOVA, or "Saturn 8") or a solid fuel NOVA, and the Apollo CM; and (4) DA using a Saturn V and a smaller, modified Apollo CM.

The factors considered in the comparison were comprehensive and detailed, including (1) overall required mission maneuvers and complexity; (2) subsystem requirements such as trajectories, guidance, control, communications and tracking, propulsion, and the lunar landing subsystem; (3) reliability and crew safety; (4) developmental complexity; (5) performance margins; (6) mission capability and growth potential; (7) human factors; and (8) schedules and costs. The study concluded that while none of the modes could be excluded as simply impossible of execution, there were technical distinctions clear enough to allow them to be ranked in order of preference on technical grounds.

It was concluded that the DA mode with a modified CM and the Saturn V was least desirable. Major considerations were the more complex yet marginal propulsion systems required and the CM size in regard to crew comfort and performance. The EOR Saturn V mode was ranked just above the DA/Saturn V option and rejected on the grounds of its lowest mission success probability and greatest development complexity. This complexity concerned the dual launch requirements (one launch for the spacecraft, one launch for the fuel) and the development of a technology for orbital fueling and for space use of cryogenic (i.e., low temperature fuel) propulsion systems. The LOR/Saturn V mode was ranked next highest. None of the many technical problems described in the body of the study were listed in the conclusions and the advantages of LOR, such as propulsion performance margin and lack of necessity for cryogenic propellants in space, were alluded to only briefly. The document made the point that a "lunar landing device that is uniquely designed for the task" was an advantage; this point was particularly attractive to the Houston engineers.

The study concluded with substantial evidence that the two NOVA DA modes were the most desirable technically, in that they were "least complex from an operational and subsystem standpoint and avoided any requirement for the development of rendezvous and docking techniques." NOVA DA also offered longer initial mission capability. With NOVA DA, 3 men could land anywhere on the moon with a science payload of 250+ pounds and stay for 7 days, whereas with LOR 2 men could land only ±20 degrees of the lunar equator with a payload of 215 pounds and stay for only 2 days. Human factors and crew safety elements were also better for NOVA DA, and the problem of development of larger launch vehicles was considered equalized with the lunar craft development problem of LOR.

"Management considerations," as the study put it, came into play at this point, however. First, the solid fuel NOVA option was foreclosed by the fact that it would render useless the work done so far on the Saturn V unless a parallel program were undertaken. Current budget allocations, NASA in-house capabilities, and NASA-DOD agreements made such a parallel program impossible. Likewise, schedule delays could best be avoided by greatest use of the vehicle systems already being developed, that is, the Saturn V and the Apollo 154 inch CM/SM. Only the LOR and EOR modes fully utilized these components, and LOR ranked one step above EOR.

Both Gilruth at MSC in Houston and Von Braun at Marshall entered petitions to the mode study in support of the LOR mode. The arguments of the two parties, however, differed strikingly. Gilruth and his Spacecraft Research Division were emphatic and technical in their recommendation of LOR, stating that they "strongly urged" LOR because of its high performance margin, minimum development requirements, simple and flexible launch operations, and significantly,

> Least compromise to the design of the vehicle or module which actually lands on and takes off from the moon.
>
> Most compact lunar landing module, thus simplifying lunar operational problems and permitting a more effective flight qualification program of the lunar landing module.

Gilruth made his statement in only a brief letter supplemented by a memorandum elaborating the technical considerations that bore on the MSC position.

Von Braun, on the other hand, entered an extensive statement, first presented June 7, 1962 at MSFC, which covered all the types of considerations that went into the MSFC decision to support the LOR mode. His statement was elaborate enough to allow insight into the full meaning of the decision for him and MSFC; because it is frank and comprehensive, it provides a rare look into the full set of contextual factors--situational, environmental, and perceptual--involved in a decision relating to huge technological efforts. For these reasons it is worth quoting at length:

> Our general conclusion is that all four modes investigated are technically feasible and could be implemented with enough time and money. We have, however, arrived at a definite list of preferences in the following order:
>
> 1. Lunar Orbit Rendezvous Mode--with the strong recommendation (to make up for the limited growth potential of this mode) to initiate, simultaneously, the development of an unmanned, fully automatic, one-way C-5 /later to be called the Saturn V/ logistics vehicle.
> 2. Earth Orbit Rendezvous Mode (Tanking Mode).
> 3. C-5 Direct Mode with minimum size Command Module and High Energy Return.
> 4. NOVA or C-8 Mode.
>
> . . . .
>
> /However/ I would like to reiterate once more that <u>it is absolutely mandatory that we arrive at a definite mode decision within the next few weeks, preferably by the first of July, 1962</u>. We are already losing time in our over-all program as a result of a lacking mode decision.
>
> . . . .
>
> I. WHY DO WE RECOMMEND LUNAR ORBIT RENDEZVOUS MODE PLUS C-5 ONE-WAY LOGISTICS VEHICLE?
>
> . . . With storable propellants, both for the Service Module and Lunar Excursion Module, we should have a comfortable padding with respect to propulsion performance and weights. The performance margin could be further increased by initiation of a back-up development aimed at a High Energy Propulsion System for the Service Module and possibly the Lunar Excursion Module.
>
> . . . .

d. We believe that the combination of the Lunar Orbit Rendezvous Mode and a C-5 one-way Logistics Vehicle offers a great growth potential.

. . . .

e. We believe the Lunar Orbit Rendezvous Mode using a single C-5 offers a very good chance of ultimately growing into a C-5 direct capability.

. . . .

k. We at the Marshall Space Flight Center readily admit that when first exposed to the proposal of the Lunar Orbit Rendezvous Mode we were a bit skeptical--particularly of the aspect of having the astronauts execute a complicated rendezvous maneuver at a distance of 240,000 miles from the earth where any rescue possibility appeared remote. In the meantime, however, we have spent a great deal of time and effort studying the four modes, and we have come to the conclusion that this particular disadvantage is far outweighed by the advantages listed above.

. . . .

II. WHY DO WE NOT RECOMMEND THE EARTH ORBIT RENDEZVOUS MODE?

Let me point out again that we at the Marshall Space Flight Center consider the Earth Orbit Rendezvous Mode entirely feasible. Specifically, we found the Tanking Mode substantially superior to the Connecting Mode. Compared to the Lunar Orbit Rendezvous Mode, it even seems to offer a somewhat greater performance margin. This is true even if only the nominal two C-5's (tanker and manned lunar vehicle) are involved, but the performance margin could be further enlarged almost indefinitely by the use of additional tankers.

We have spent more time and effort here at Marshall on studies of the Earth Orbit Rendezvous Mode (Tanking and Connecting Modes) than on any other mode. This is attested to by six big volumes describing all aspects of this mode. Nor do we think that in the light of our final recommendation--to adopt the Lunar Orbit Rendezvous Mode instead--this effort was in vain. Earth Orbit Rendezvous as a general operational procedure will undoubtedly play a major role in our over-all national space flight program, and the use of it is even mandatory in developing a Lunar Orbit Rendezvous capability.

. . . .

IV. WHY DO WE RECOMMEND AGAINST THE NOVA OR C-8 MODE?

. . . .

c. Implementation of the Nova or C-8 program in addition to the Advanced Saturn C-5 would lead to two grossly under-funded and undermanaged programs with resulting abject failure of both. Implementation of the Nova or C-8 program in lieu of the Advanced Saturn C-5 would have an absolutely disastrous impact on all our facility plans.

The rafter height of the Michoud plant is 40 feet. The diameter of the S-IC is 33 feet. As a result, most of the assembly operations for the S-IC booster of the C-5 can take place in a horizontal position. Only a relatively narrow high bay tower must be added to the main building for a few operations which must be carried out in a vertical position. A Nova or C-8 booster, however, has a diameter of approximately 50 feet. This means that the roof of a very substantial portion of the Michoud plant would have to be raised by 10 to 20 feet. Another alternative would be to build a very large high bay area where every operation involving cumbersome parts would be done in a vertical position. In either case the very serious question arises whether under these circumstances the Michoud plant was a good selection to begin with.

The foundation situation at Michoud is so poor that extensive pile driving is necessary. This did not bother us when we acquired the plant because the many thousands of piles on which it rests were driven twenty years ago by somebody else. But if we had to enter into a major pile driving operation now, the question would immediately arise as to whether we could not find other building sites where foundations could be prepared cheaper and faster.

Any tampering with the NASA commitment to utilize the Michoud plant, however, would also affect Chrysler's S-1 program, for which tooling and plant preparation are already in full swing at Michoud. Raising the roof and driving thousands of piles in Michoud may turn out to be impossible while Chrysler is assembling S-1's in the same hangar.

In summary, the impact of a switch from C-5 to Nova/C-8 on the very concept of Michoud, would call for a careful and detailed study whose outcome with respect to continued desirability of the use of the Michoud plant appears quite doubtful. We consider it most likely that discontinuance of the C-5 plan in favor of Nova or C-8 would reopen the entire Michoud decision and would throw the entire program into turmoil with ensuing unpredictable delays. The construction of a new plant would take at least 2-1/2 years to beneficial occupancy and over 3 years to start of production.

d. At the Marshall Space Flight Center, construction of a static test stand for S-IC booster is well under way. In its present form this test stand cannot be used for the first stage of Nova or C-8. Studies indicate that as far as the noise level is concerned, there will probably be no objection to firing up eight F-1 engines at MSFC.

. . . .

g. One of the strongest arguments against replacement of the Advanced Saturn C-5 by Nova or C-8 is that such a decision would topple our entire contractor structure. It should be remembered that the temporary uncertainty about the relatively minor question of whether NAA should assemble at Seal Beach or Eglin cost us a delay of almost half a year. I think it should not take much imagination to realize what would happen if we were to tell Boeing, NAA and Douglas that the C-5 was out; that we are going to build a booster with eight F-1 engines, a second stage with eight or nine J-2's or maybe two M-1 engines; and that the entire problem of manufacturing and testing facilities must be re-evaluated.

. . . .

i. More than twelve months of past extensive effort at the Marshall Space Flight Center to analyze and define the Advanced Saturn C-5 system in a great deal of engineering detail would have to be written off as a flat loss, if we abandoned the C-5 now. This item alone, aside from the time irretrievably lost, represents an expenditure of over one hundred million dollars.

With the weight of both Von Braun's and Gilruth's opinion in back of it, the LOR configuration was adopted as the prime mode for the lunar mission.

When the decision was announced on July 11, 1962, there was, expectedly, a good deal of surprise among observers of the space program.

John Finney wrote the following day in the N. Y. Times that the LOR method was a "major change in plans" for NASA, and said that:

> Until now, the favored approach has been the earth rendezvous method. The space agency's budget for the current fiscal year, for example, was justified before Congress on the basis of development of the earth rendezvous technology.

Much more important than such reactions as these, however, was the quiet, intense storm over the mode decision that broke out between NASA and the President's Science Advisory Committee. As noted above, the mode study remained classified until 1968, and virtually all of the controversy among space officials about the mode decision was closed; however, this disagreement was intense and had many facets, some of which involved charges of political and personal dealings that are still in obscurity.

The thrust of PSAC's criticism came from Jerome Wiesner, head of PSAC and Kennedy's science adviser; he was backed by a PSAC panel report, "On the Matter of the Lunar Mission Mode Selection,"dated July 26, 1962. Major objections revolved around the lack of technical substantiation for its decisions provided by NASA--PSAC charged that NASA had made the decision on "non-technical" grounds--and hit hard at the point that a bias was injected into consideration of all modes by the "three man crew" assumption. Wiesner wrote NASA Administrator Webb on July 17, before sending the report, to express preliminary feelings:

> The matter of which mission mode is most consistent with the main stream of our national space program, and therefore with the one most likely to be useful in overtaking and keeping ahead of Soviet space technology, is also one that I believe requires further consideration. For example, if LOR is chosen and the NOVA slipped by two years, then the U.S. will most likely not have an escape capability significantly above 90,000 pounds until 1971 or 1972 at the earliest. With EOR and Saturn 5 Direct, on the other hand, a capability of 160,000 pounds to escape will be available in 1966 or early 1967. Which of these situations, broadly considered, is best for the U.S. posture in space? Similarly, the question of which mode is likely to be most suitable for enhancing our military capability in space if doing so should turn out to be desirable, should be reviewed with care.
>
> Finally, as has been emphasized by the /PSAC/ Space Vehicle Panel, the NASA studies of mission modes did not present the relative advantages and defects of each on a valid basis for comparison principally because some modes involved the use of three men in critical mission mode phases while others used only two. Payload margins

> and crew survival probability for the various alternatives are both likely to change substantially, in the Panel's opinion, if the EOR and the Direct modes are carried out using a crew of only two men.

The conclusions to the PSAC report later delivered to Webb stated more explicitly the objections to the decision:

> 1. The clearest point which has emerged from our efforts has been that <u>if</u> a two-man crew is adequate for the most difficult part of the LOR mission, namely, lunar landing, lunar exploration, lunar vehicle checkout, precisely timed lunar takeoff and rendezvous, then it cannot be persuasively argued that <u>three</u> men must be landed in other modes.
>
> 2. <u>Therefore</u>, we recommend that the perturbation introduced into the other estimates by a reduction in crew size from three to two men be obtained in the next few weeks.
>
> 3. In terms of a long-range national program involving larger payloads on the moon, space stations in earth orbit, etc., it seems to us that more essential skills and technology are acquired in earth orbital refueling than in LOR, which is a highly specialized mode. Also, although we have not considered it deeply, earth orbital rendezvous and refueling operations seem more directly related to potential military uses.
>
> 4. Consequently, all of the members of the Panel would pick EOR over LOR on the basis of the technical information available to us.
>
> 5. . . . Although we would agree that it does not seem wise to base a mission on this expectation, a two-man capsule designed for the EOR mode could probably be carried directly on a C-5 (without using H_2-O_2 for lunar landing or takeoff) if this expected growth were realized. If it did however, Direct Ascent would become our favored mode and would involve no new developments.
>
> 6. Therefore, we recommend a choice of EOR with a two man capsule together with a strong effort to upgrade the performance of the C-5 as it is developed in which case the Direct Ascent utilizing the same

> Apollo spacecraft may become available for an early attempt. In order to exploit this possibility efficiently, it is essential that the effort to upgrade the F-1 engine be initiated within the next few months.10/

Webb's response to Wiesner and the PSAC report was to indicate that the agency's documentation of technical reasons for adopting LOR had not had a chance to "catch up" with the "steady movement of NASA people's minds" toward the LOR option. He further noted to Wiesner that NASA had under way continuing studies of the Saturn V DA mode with a two-man capsule, another DA study by the Space Technology Laboratory, and a design study by McDonnell Aircraft of a two-man lunar mission module; the results of these would be available shortly for further consideration in regard to the DA and EOR mission profiles as these compared with LOR.

NASA therefore adopted the strategy of having LOR as the prime mode, but with the possibility left open that it would be dropped and a backup mode chosen at a later point. The agency continued study and development efforts that supported the other modes. The conditions surrounding the mode decision were too ambiguous to permit a single-minded, clear-cut course to be pursued. As events turned out, however, the lunar mode decision had important types of influences on future decisions concerning what the program following the moon landing would be. Some arose directly from the future program recommendations contained in the mode study, some from the physical facts of the LOR mode hardware configuration, and some from the longer-run organizational impacts on NASA and its centers. Others stemmed from implicit credits and obligations that are created by administrative decision situations where there is ambiguity and one party's stakes prevail over those of another, as those of the Houston Center did over those of Von Braun and the Marshall Center in this instance.

A Situational-Perceptual Element: The Air Force Space Program Plans

The establishment of NASA's space programs and the transition from NACA, as noted earlier, were more than slightly problematic. The greatest number of difficulties revolved around the transfer of military space-related programs, particularly of those involving manned space flight, to the new agency. Eisenhower's space policies did nothing to alleviate the damaged feelings that the transfers created in the Air Force. The

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10/ President's Science Advisory Committee, "On the Matter of the Lunar Mission Mode Selection" (a report), July 26, 1962.

latter disagreed with Eisenhower on the basic point of the military value of space and thus of the desirability of emphasizing space for "peaceful" uses. It felt further that it had established greater managerial competence for controlling the development of space programs. When the NASA budget outstretched the Defense space budget (mostly for the Air Force) in 1961, Air Force officials began to mount a campaign for a reemphasis of military space programs under the new Kennedy administration. General Bernard Schriever, top Air Force spokesman on space, assembled a blue-ribbon panel to study future military space programs; just after Kennedy's election a confidential memorandum from the Office of the Secretary of the Air Force announced to top Air Force officials and contractors that the Air Force and NASA probably soon would be engaging in a battle for the dominant role in space programs.11/ The Air Force argued that future national security depended on space and that it was best able to handle the development of space programs. It sought to restrict NASA's role to that of NACA--purely research and development to be used in operations of other agencies. It was successful in mustering some support from both the aerospace industry and the press for restructuring the nation's space effort in favor of the military.

Thus at the same time NASA was attempting to cope with such basic issues as what mission mode to use for a lunar landing, it was faced with an external challenge to the very appropriateness of its role as an agency. However, in the early stages of this struggle the Air Force had little specific content to its conceptualization of the military role of space, other than that of developing space weapons systems and that it wished to enter the manned space field through interstices in the NASA program.

At the start of the 1960's, NASA initiated work on a manned space station program. It established a project office for this purpose within the Engineering and Development Group of the Spacecraft Research Division at the Houston Center and carried out initial planning. At a June 1962 meeting between NASA space station planners and officials of the Air Force Systems Command concerning manned space stations, the Air Force-NASA competition quickly came into focus over the space station mission. A NASA memorandum prepared as a record of the meeting described the major thrust of the participants' positions.

> The Air Force is apparently planning a manned earth orbital research and development facility based upon the Titan III launch vehicle and the Gemini spacecraft. It appears that they have set their sights on a relatively modest effort, using proven hardware when possible in an attempt to get early program approval.

11/

This background picture is taken from Logsdon, The Decision to Go to the Moon: Project Apollo and the National Interest.

> A research and development type station has been selected as their target because they have had little success to date in obtaining U.S. Air Force approval for any manned space flight weapon system. . . . I believe, however, they see a gap in space laboratory capability, between what can be done in the Apollo Command Center and a large C-5 sized station which they understand we have decided to develop. They will propose that an interim station be developed which can become operational before a first . . . /NASA/ station. It is therefore likely that Air Force Members of the Manned Space Flight Panel . . . may propose that USAF independently conduct an interim space station program. . . . Little difficulty /can be anticipated/ in defending /our/ position at this time, because from /their/ questions they are yet trying to develop their justification for a station and are working on a program of tasks. . . . /A visit is planned/ to the Manned Spacecraft Center . . . and obtaining a list of tasks to be performed in space stations /is apparently/ a major objective of the visit.

A later document prepared for a "Program Status Review" that was based on this memorandum and described the Air Force-NASA interactions about space stations clearly reflected the framework of competition that had developed on the space station matter. The Air Force space station, therefore, later designated the Manned Orbiting Laboratory (MOL), appeared early as a factor to be reckoned with in NASA's planning of the general post-Apollo manned flight program.

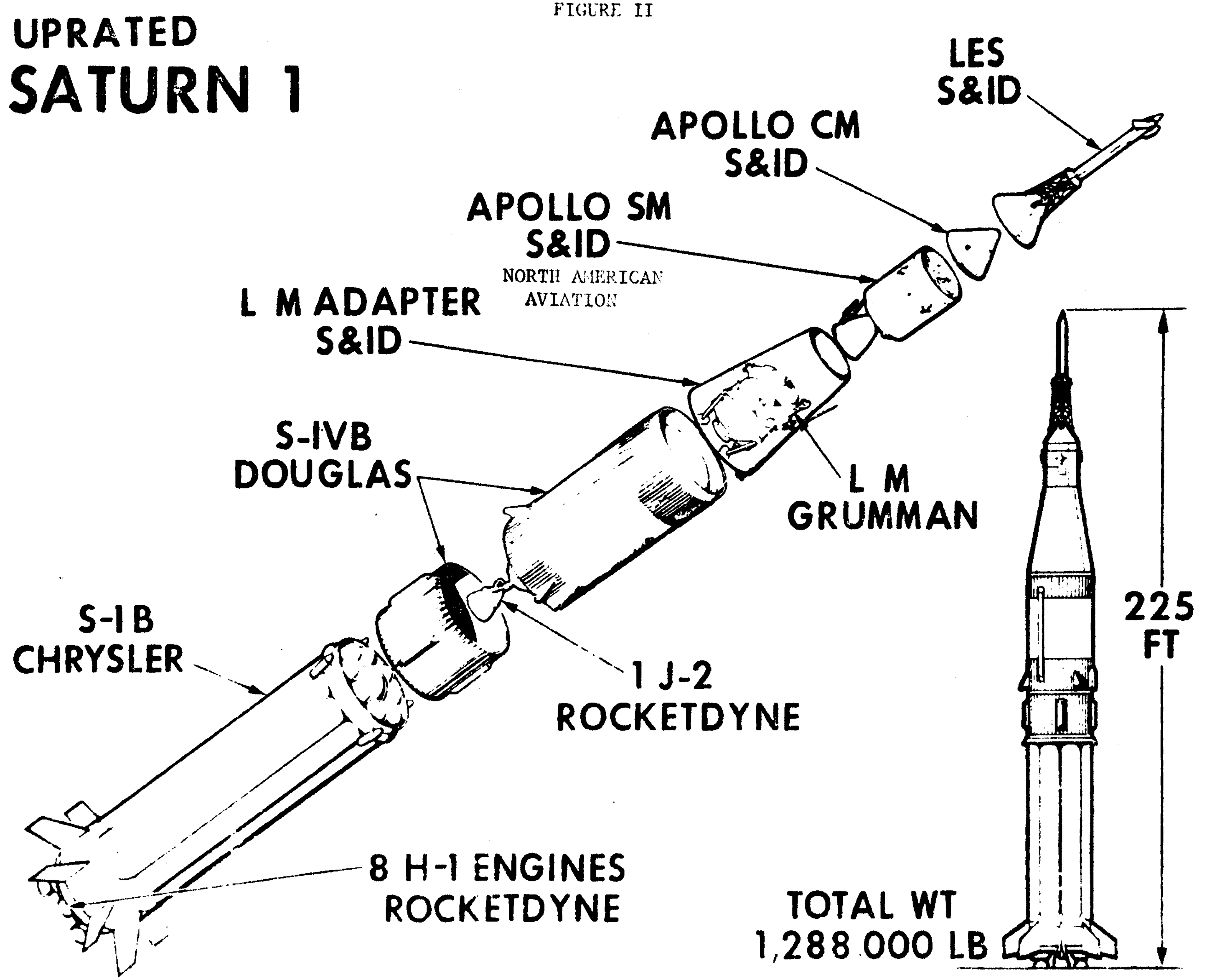
Technical Description of Apollo Hardware

In Chapter I, technology was listed as a major component of the environment of decisions. As such, it is essential to know the technical base on which programmatic decisions are taken. This imperative requires that a description be given of the technical characteristics of the hardware used in the Apollo program. The direct relevance of this sketch quickly will become obvious as the narrative of this story unfolds. Cognizance of many of the technical aspects of the Apollo hardware system is so important to understanding and following the story of post-Apollo, in fact, that these aspects will be presented in some detail here.

The Saturn IB Booster

Figure II below shows the Apollo hardware configured on the Saturn IB booster, an uprated version of Saturn I. The booster possesses a 100 nautical mile earth orbit payload capability of about 40,000 pounds. It has two propulsive stages: an S-IB first stage composed of a cluster of

FIGURE II



UPRATED
SATURN 1
LES
S&ID
APOLLO CM
S&ID
APOLLO SM
S&ID
NORTH AMERICAN
AVIATION
L M ADAPTER
S&ID
S-IVB
DOUGLAS
L M
GRUMMAN
S-IB
CHRYSLER
1 J-2
ROCKETDYNE
8 H-1 ENGINES
ROCKETDYNE
TOTAL WT
1,288 000 LB
225
FT

eight H-1 engines that burn kerosene and liquid oxygen and produce a combined thrust of 1.6 million pounds, and the S-IVB stage, composed of a single J-2 engine that burns liquid oxygen and liquid hydrogen at a vacuum thrust (i.e., under its actual use condition) of 1,230,000 pounds.

The Saturn V Booster

The Saturn V, shown in Figure III, has three propulsive stages: the S-IC, the S-II and the S-IVB. The S-IC is made of five F-1 (kerosene-liquid oxygen) engines, with an overall thrust of 7.7 million pounds. The S-II is a cluster of five J-2 liquid oxygen-liquid hydrogen engines producing 1,125,000 pounds of thrust. The S-IVB is the same as on Saturn IB with the addition of a second burn capability. The Saturn V is the largest rocket in operation; it represents the greatest controlled use of energy on earth. Whereas Saturn I boosts only 40,000 pounds into a 105 mile low inclination orbit, Saturn V can boost over 100,000 pounds into an earth-moon trajectory, or 285,000 pounds into a 105 nautical mile low inclination orbit.

The Apollo Spacecraft

The Apollo spacecraft basically consists of three parts: a command module (CM), service module (SM), and lunar module (LM, earlier identified as the Lunar Excursion Module or "LEM"), housed during flight in a spacecraft-lunar module adapter (SLA). The overall configuration, including launch escape system, is shown in Figure IV.

Shown in Figure V is the Apollo Command Module; captions indicate main design characteristics. It contains crew supplies and all controls and displays, and affords a habitable environment for three men. The exterior is heat and radiation protective; an ablative heat shield affords resistance to reentry heating effect.

Directly behind the CM is the Service Module (CM and SM are "CSM"), shown in Figure VI. It contains the propulsion capability for insertion into and from lunar orbit and for trans-lunar midcourse correction. It also contains fuel cells providing electrical power, radiators for spacecraft cooling, and oxygen and hydrogen supplies. The SM necessarily remains connected to the CM for the duration of the space flight, but it is separated from the CM before earth entry and not recovered.

In the Apollo program, the actual moon landing is effected in the Lunar Module (LM). The LM is made in two stages, descent and ascent. The descent stage (Figure VII) is unmanned and remains on the lunar surface

FIGURF III

SATURN V

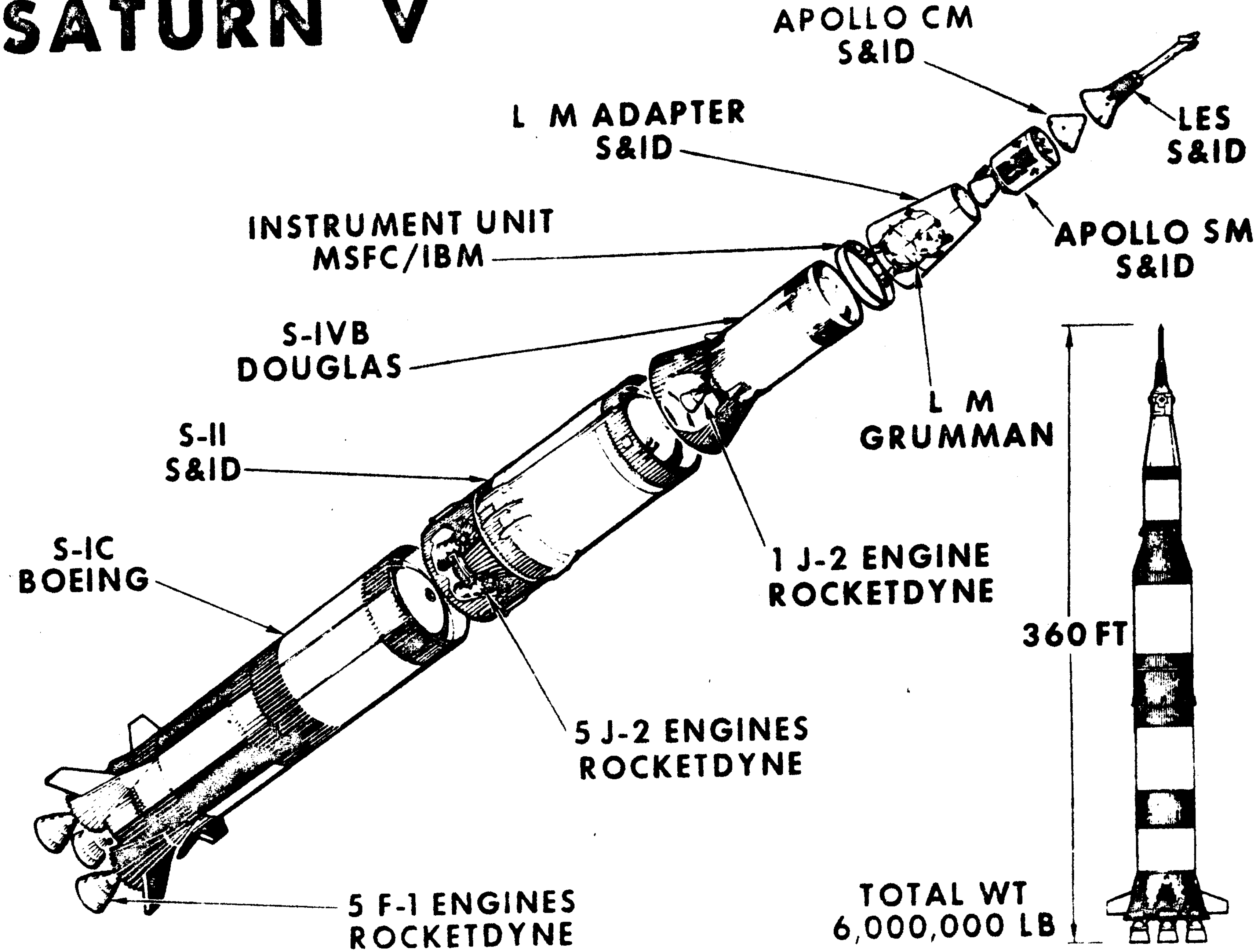


FIGURE IV

APOLLO SPACECRAFT

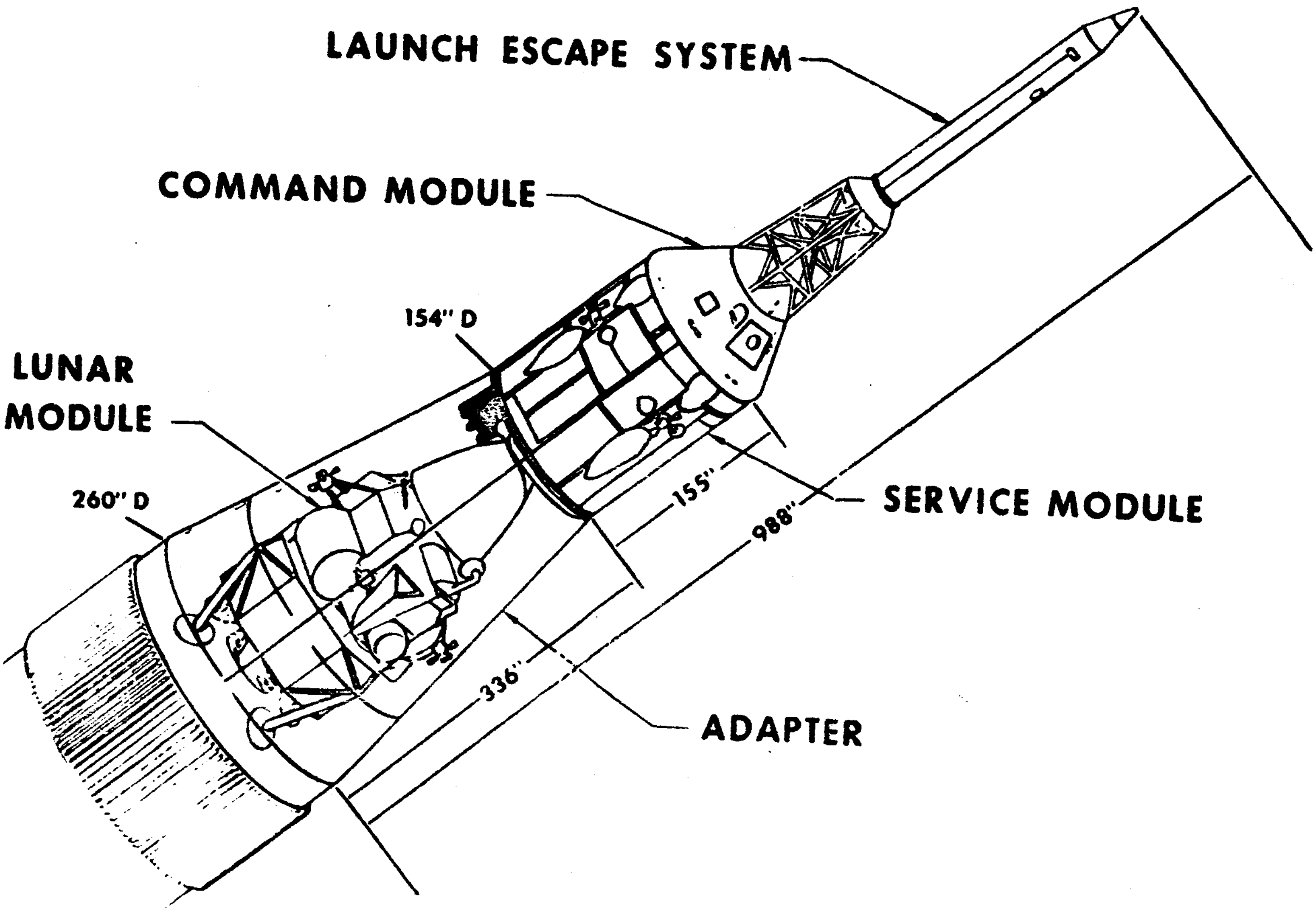
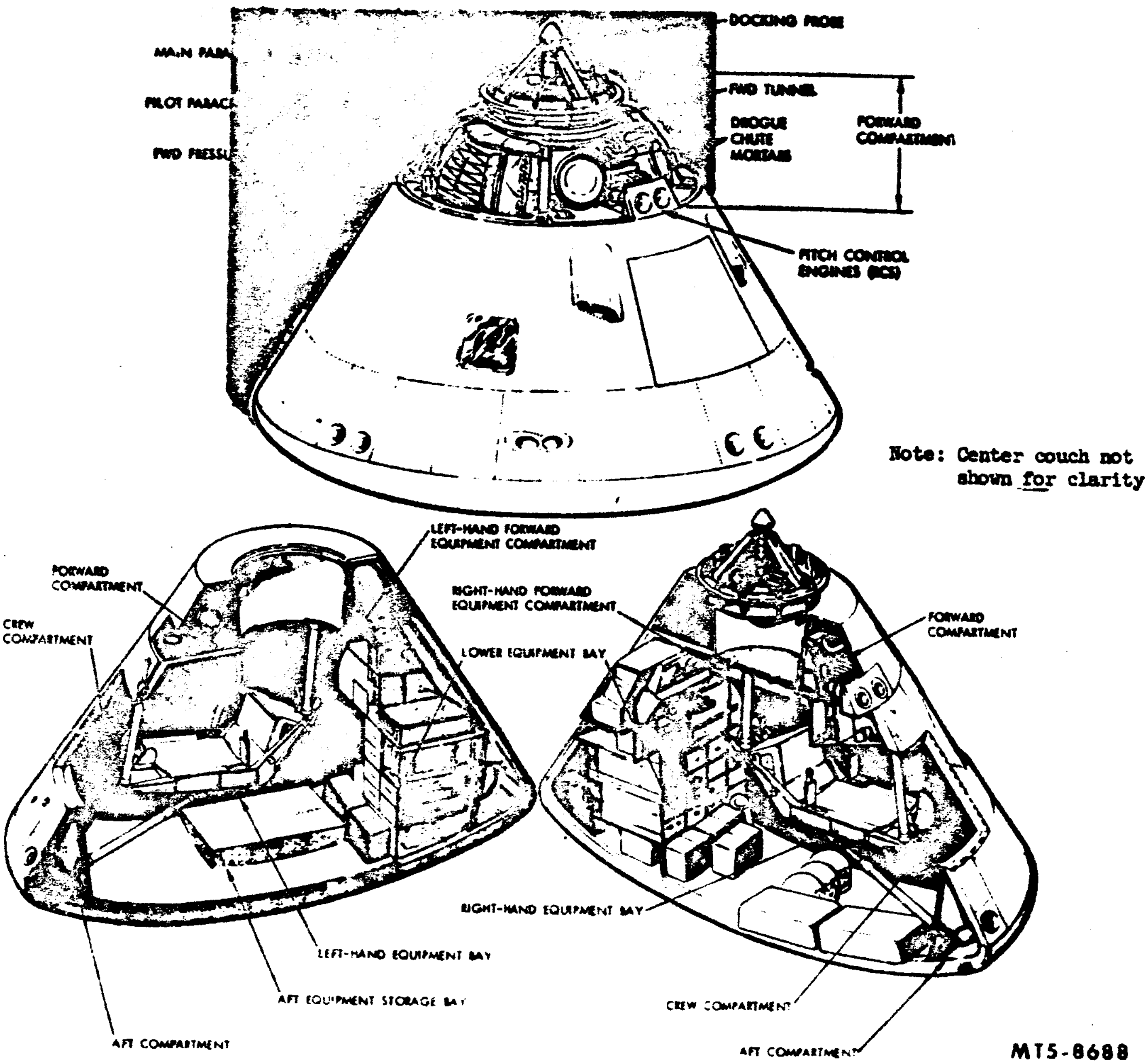


FIGURE V

CUTAWAY VIEWS OF THE COMMAND MODULE



MT5-8688

FIGURE VI

BLOCK II SERVICE MODULE

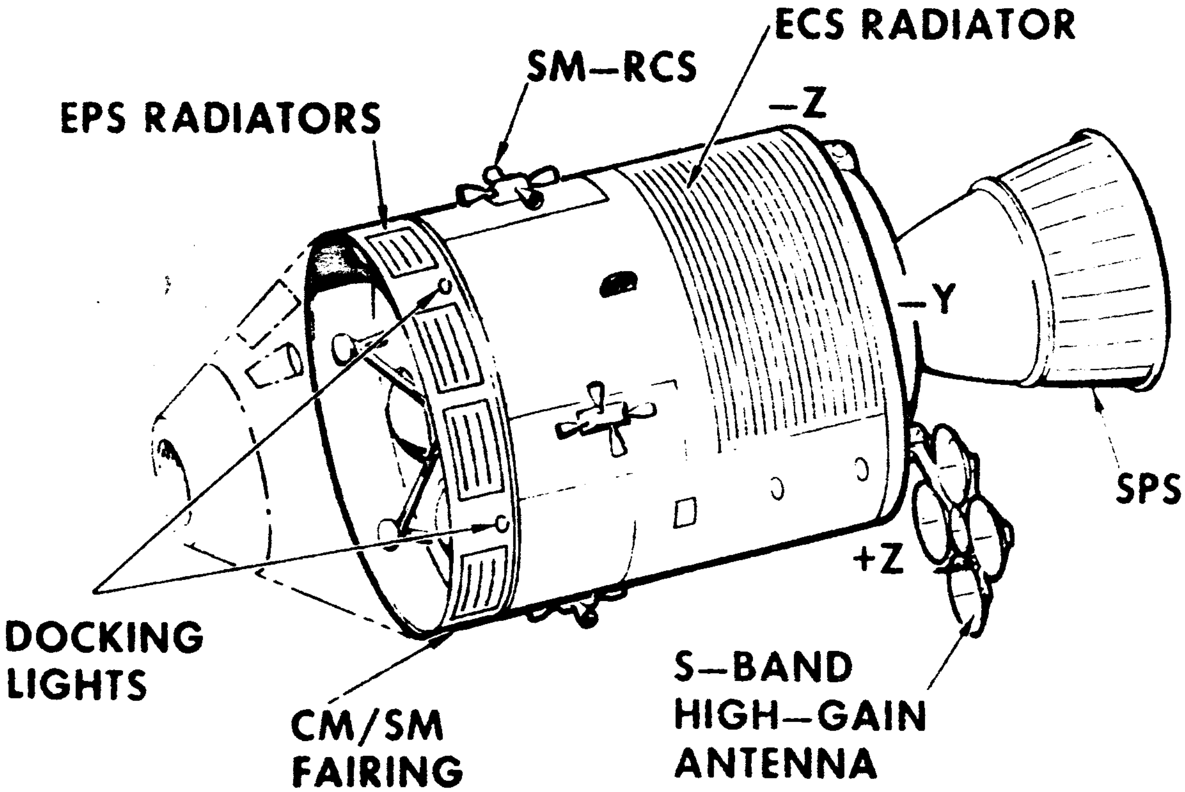
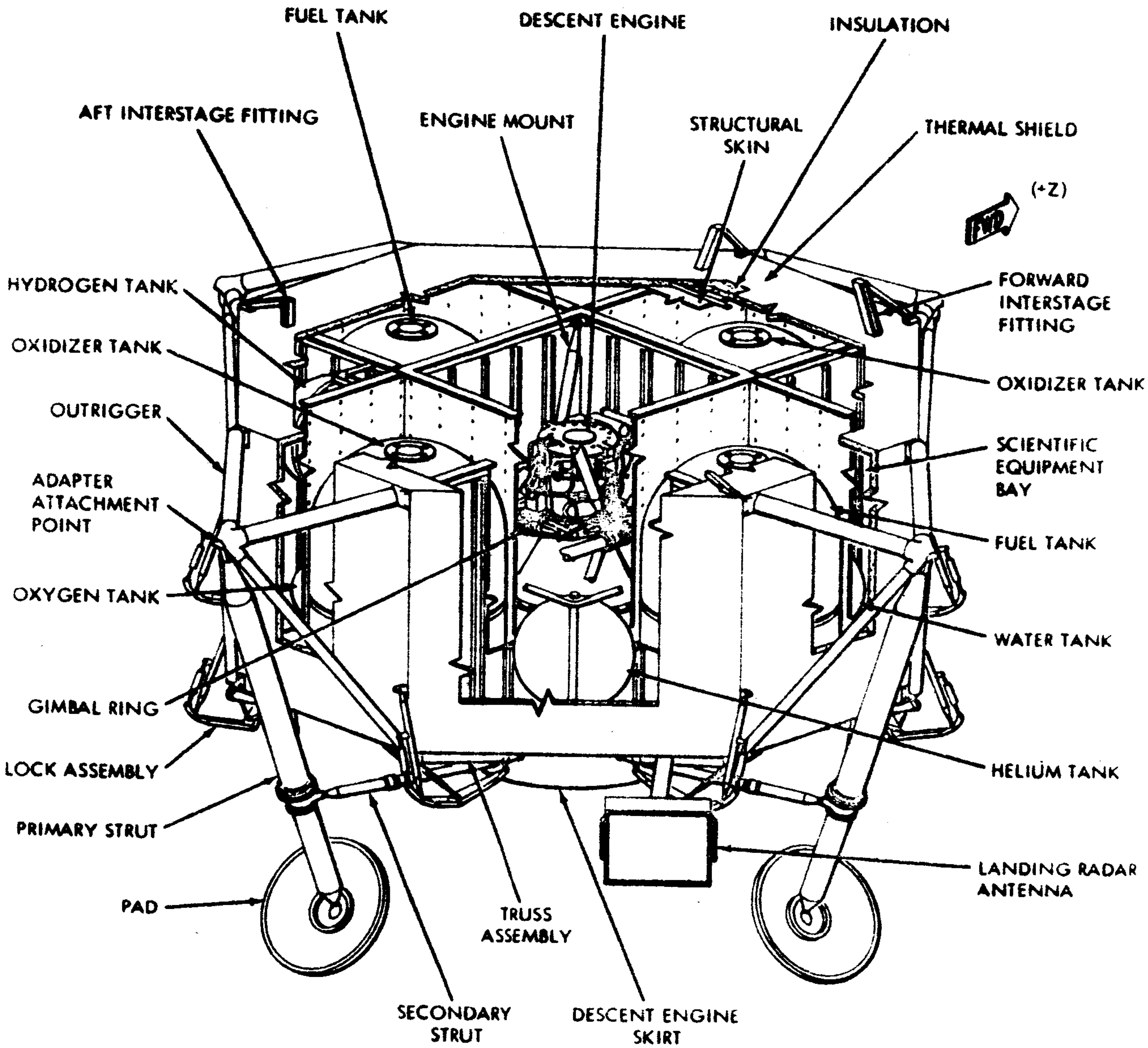


FIGURE VII



LM DESCENT STAGE

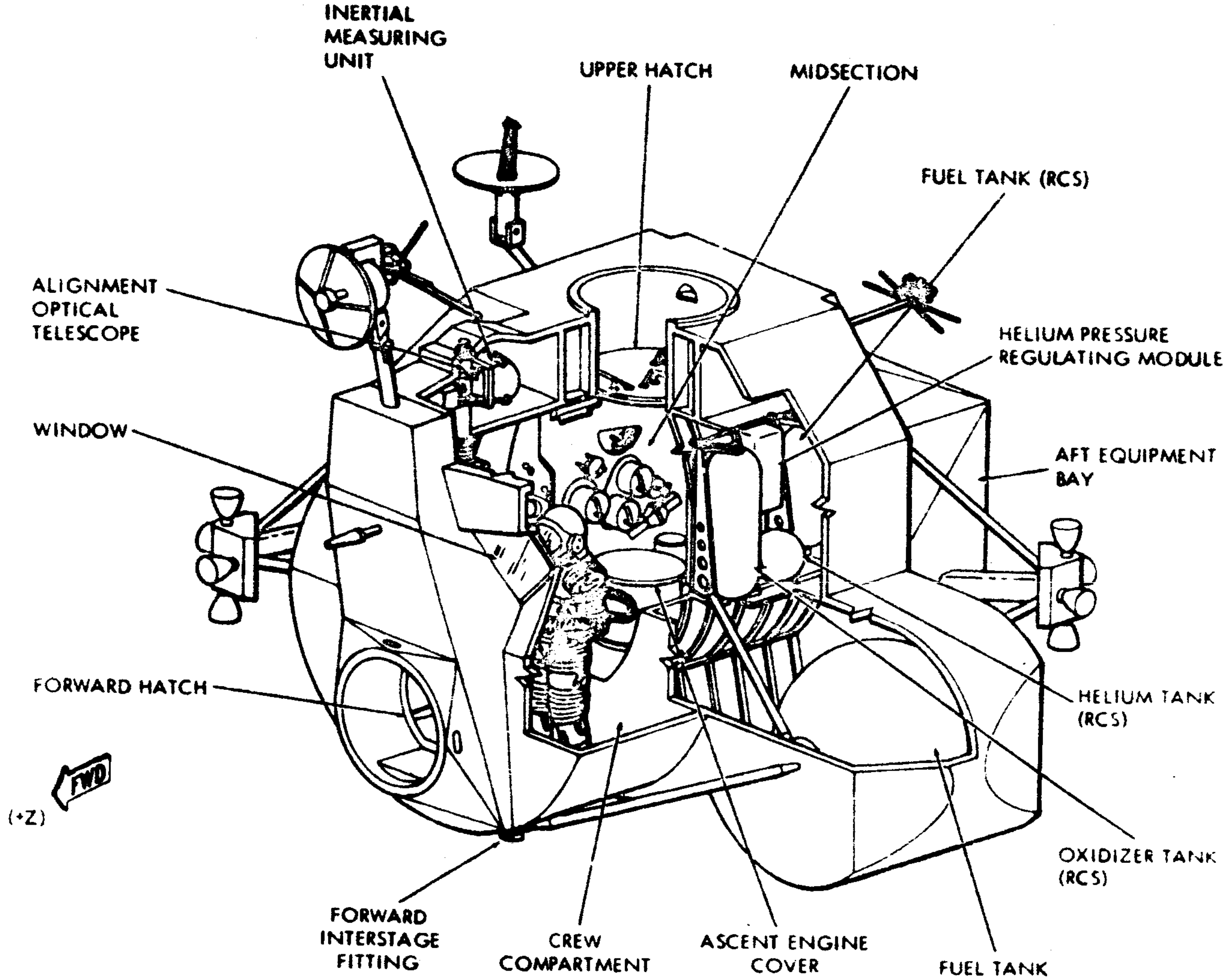
NOTE:
LANDING GEAR SHOWN IN
RETRACTED POSITION

after serving as a launch platform for the ascent stage. The ascent stage (Figure VIII) houses two men in an oxygen environment with communication and control equipment and supplies for 45 hours. It contains the propulsion and guidance capability for landing on and leaving the lunar surface, rendezvous, and docking with the CM in lunar orbit.

In trans-lunar flight on the Apollo manned landing mission, the CSM will move out from the S-IVB stage configuration that is inserted into the lunar trajectory, "transpose," and dock with the LM, remove it from the S-IVB and allow entry of the two crew members into the LM, as shown in Figure IX. To facilitate this maneuver, as well as to support the CSM and house its engine nozzle in addition to the LM, is the Spacecraft-Lunar Module Adapter (SLA), shown here as Figure X. This is a monocoque structural interstage between the S-IVB stage and the CSM. It consists of panels containing linear explosive charges at the junctions. When the CSM moves out from the S-IVB during flight, the charges fire, cutting apart and jettisoning the panels, hence permitting the CSM-LM docking operation.

This, in rough overview, is the hardware developed for the Apollo mission, which, it turned out, formed the foundation for NASA's conceptualization of the major part of its post-Apollo manned space flight program.

FIGURE VIII



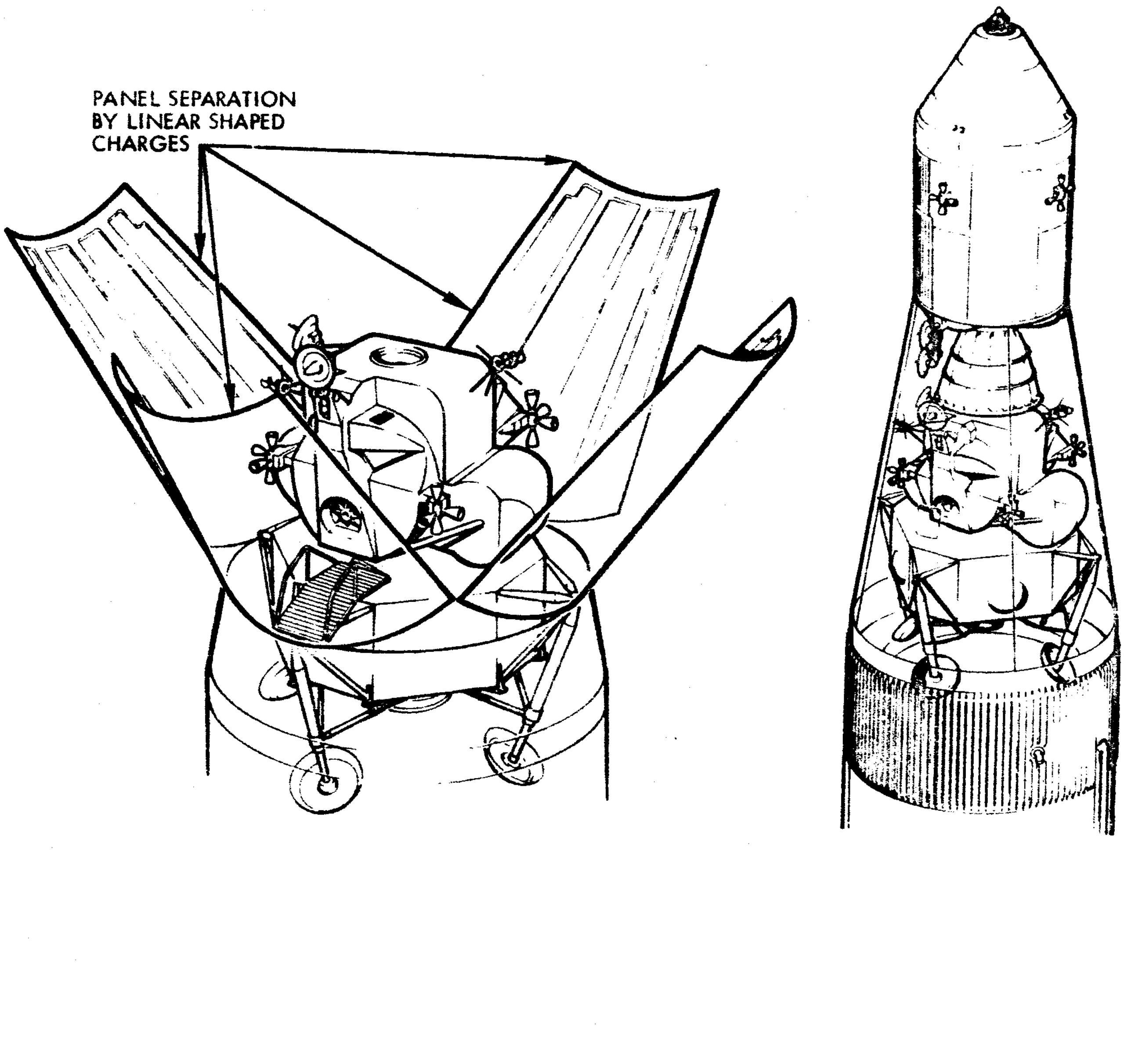
LM ASCENT STAGE

FIGURE IX

AN ILLUSTRATION OF THE TRANSPOSITION AND DOCKING SEQUENCE OF THE CSM AND THE LM

FIGURE X

SPACECRAFT LM ADAPTER



CHAPTER IV

DEVELOPMENT OF A MANNED POST-APOLLO PROGRAM IN NASA--INTERNAL AND TECHNICAL ISSUES

Introduction

The reality of human institutions is most significantly subjective in nature; it is a reality that can be (and is) defined in various ways by people in and outside of institutions. Hence, while a description of "the issues" involved in the process of program development in a large administrative agency can be based on the occurrence of certain concrete events, the options, stakes, and implications of events exist in the worlds of subjective experience--either organizational or personal--that are involved in the process. The problem of grasping such a reality is exacerbated where technical issues are involved. In numerous cases, resolving such issues is, in effect, a process of "defining the reality" of a situation. Thus, frequently to the side that prevails in a technical decision there appears to have been no issue because there were "in reality" no true alternatives to the course of action that was taken.

The following description of the issues that arose in the development of NASA's manned flight post-Apollo program will reflect both the events that took place and a rather wide variety of perspectives defining these events. The issues themselves, in their technical aspects, dealt with the specifics of how the hardware components and experiments for the near term post-Apollo program were configured and developed. The variety of perspectives on these issues was great. As always, there were individuals with personal career stakes involved. There were perspectives at various levels of the NASA organization. At the top levels, for example, there was one dominant objective: to increase the overall space technology capability of the United States as an element of international strategy; and one general policy premise: to build from the Apollo capability as far as possible. At this level hardware configurations and payload development were relatively unimportant. At lower levels the organizational perspectives centered in the Office of Manned Space Flight and in the Office of Space Sciences and Applications interacted under the general issue of "space science" versus "manned flight capability." Within the manned flight area, the

NASA centers displayed perspectives toward specific issues of hardware configuration that conflicted with each other. In such a case, where a multiplicity of varying perspectives was present, any discussion of issues is of necessity as analytical as it is concrete.

Such issues can be based on a concrete foundation of decisions, however. This foundation is formed by the set of decisions that produced the transition from the hardware configuration for the post-Apollo program that had emerged from the initial lunar logistics and Apollo extensions studies to that presented to Congress in the 1968 and 1969 budget proposals. In order to firmly set the mortar of this foundation, it is necessary to describe these early studies before detailing the decision issues that arose as the agency moved beyond these early planning premises.

The LLS and AES Studies

One of the NASA headquarters management concerns that quickly developed as the magnitude of the Apollo effort took shape was that agency headquarters would not be able to marshal the independent engineering expertise necessary to countervail the power of the field centers in a program as broad and complex as Apollo. In order to develop a group with the required technical expertise William Taylor was brought into NASA headquarters in May 1962. Taylor immediately became involved in the lunar landing mode decision, since this was the chief technical task to be faced at that time. His job changed quickly, however, after the mode decision was made.

As part of his statement in the lunar mode study Von Braun had coupled his endorsement of the LOR mode with a "strong recommendation" that development of a lunar logistics system (LLS) using the Saturn be carried out as part of the Apollo program. The 1963 manned space flight long-range plan had echoed this recommendation as part of the manned lunar landing program. It also reflected a concern in the agency that a "weight problem" might develop on Apollo, which would delay the program unless a backup system were ready for deployment. The plan stated that the LLS significantly could increase assurance of mission success and crew safety on the Apollo mission because it would:

1. Prepare the site (with supplies) for the manned landing.

2. Extend lunar stay-time and allow repair and replenishment of the LEM.

3. Extend scope and value of the lunar surface exploration by the Apollo astronauts.

4. Enable lunar rescue operations on Apollo missions (through extension of stay time and provision of needed articles).

5. Allow acquisition of lunar surface data in case unmanned programs did not yield adequate information.

Mueller appeared sensitive to the need for a logistics system; in August 1962 he gave Taylor the task of carrying out the studies necessary to the implementation of the Von Braun suggestion for the LLS. Taylor was assisted in this task group effort by Ed Andrews at NASA, Space Technology Laboratory, Northrup Space Laboratories, Grumman Aircraft Engineering Corporation, and Bellcomm, an independent space systems analysis subsidiary of Bell Telephone Laboratories that is attached to NASA. The NASA Marshall Center also participated. The LLS task group reported in April 1963, after a period of intensive study that was monitored and directed closely by Mueller.

The report on the study acknowledged the lunar mode decision as the source for the concern with the lunar logistics system, and stated ground rules for the LLS study that made clear it was not to involve development of unique hardware systems either for LLS spacecraft or for boosters. The boosters to be used in LLS were the Saturn IB and the Saturn V; operation target dates were set for mid-1966 or mid-1967. The report placed great emphasis on not letting LLS interfere with the development of the Apollo program, and on the desirability of having an LLS capability as a backup to the first Apollo missions. It also stressed the utilization of available technology to minimize costs and schedule delays. One rule related to this emphasis is of particular note:

12. Results of advanced research and development should only be incorporated where significant improvements can be achieved within acceptable reliability limits.

In contrast to the usual NASA practice of contracting for the overall conceptual design of a system, the LLS was broken down into major subsystem components and each of these studied in depth. Space Technology Laboratories executed a study of the "delivery spacecraft subsystem" or "Spacecraft Bus," while Grumman and Northrup studied "payload performance." These studies analyzed emergency and stay time extension for Apollo crews, extension of data acquisition, equipment for manned and unmanned lunar surface exploration, and capability for landing site preparation. The Marshall Center studied five LLS areas: trajectory analyses, design of lunar landing stage propulsion systems, the use of Saturn vehicles in LLS, "touchdown dynamics" for various lunar surface conditions, and a "trafficability study" for lunar roving vehicles on numerous surface conditions. Bellcomm and the OMSF Office of Systems conducted in-house studies related to LLS.

One study was an analysis of the relation of the unmanned Ranger and Surveyor projects to Apollo, but more important was an overall evaluation of the LLS concept.

On the basis of a general evaluation of the LLS studies by OMSF, the study group drew a number of important conclusions. Among these was the idea that an LLS capability was not essential to the success of the first manned lunar landing if an adequate landing site had been selected and verified. However, LLS was seen as essential to any adequate scientific exploration on the moon, and as a backup method of attaining confidence in an Apollo lunar landing site for the initial Apollo mission. The report also concluded that logistic support after the first Apollo landing was a necessary step in any follow-on development for further moon-based operations.

Perhaps the most significant outcome of the LLS studies was the conceptualization of a dual approach to lunar logistics. What Von Braun had in mind at the time of the lunar mode decision in urging the development of a logistics system was a fully automated, one-way, unmanned cargo carrier utilizing space on the Saturn IB and/or the Saturn V boosters. As the LLS studies were carried out, however, an alternative concept developed that visualized the logistics vehicle as a modified, unmanned LEM--given the designation "LEM Truck"--that would be carried in place of the manned LEM with the Apollo CM. The report stated that:

> The choice between the LEM Truck and the Saturn V LLS cannot be made on purely technical grounds. Both are technically feasible and either could be made available in time to give real value to the Manned Lunar Exploration Program.

While the LEM Truck would cost less than half of the Saturn V LLS to develop, it would cost more than the Saturn craft on a per launch basis. The Saturn "rocket-craft" offered a much greater payload capacity than the LEM Truck (25,000-30,000 for the Saturn as opposed to 7,000-9,000 for the LEM). Other factors seemed to weigh in favor of the Saturn vehicle. The Saturn V LLS would be operational only about six months later than the LEM Truck; it would interfere only indirectly with Apollo (in the sense of making discrete demands for resources and management supervision) whereas the LEM Truck would compete directly; and the developments needed for the Saturn craft would provide a foundation for a better Apollo backup, for improvements in the Apollo SM, and for the propulsion requirements of the unmanned "Voyager" science program.

On March 26, 1963 the OMSF Management Council met to discuss the LLS program. The Council concluded that it was appropriate to start a program for extending lunar surface stay time to at least two weeks but that no decision could be made about the establishment of a lunar base. To implement this conclusion it certified the LEM Truck as the LLS vehicle, to be available by the time of the first Apollo mission. It also recommended necessary ancillary studies and proposed development of a cryogenic third stage for the Saturn IB, the usage of which would be coordinated with the Office of Space Sciences.

As was pointed out above in discussing NASA's early long-range plans, there was much support in the agency for the idea that a space station program should be carried out concurrently with Apollo, both for the intrinsic worth of the opportunities offered by space stations and as a necessary step to further space exploration. Consequently, very early in its history the agency carried out "advanced mission" studies of space stations. The initial group of studies explored a wide variety of space station configurations, ranging from extending the Apollo craft capabilities to allow a ninety-day stay in earth orbit to concepts of huge artificial gravity stations. The mission objectives of these emphasized answering some of the basic biomedical questions about long-duration flights.

Of this range of studies a small number were selected for further development. One of those selected was the concept of a low-development-cost vehicle, constructed of either a modified Apollo spacecraft or an Apollo supplemented with a subsystem of additional life support expendables in a "one-way" module that would be left in orbit when the crew returned to earth. These studies--variously designated "Apollo X," "Apollo Extensions," and "Extended Apollo"--started in FY 1963 with funding of a study contract to North American Aviation and continued through FY 1965. They concluded that the Apollo craft could be used in extended duration earth orbit missions, but with definite limitations, and that early definition of "mission-experiment" aspects was essential to setting the spacecraft configuration. There had been some interest, led by Max Faget, in a Large Orbiting Research Lab (LORL) concept based on a projected 36-man crew, but this idea did not attract much attention relative to the Apollo-X concept.

After completing the work on the LLS studies, Taylor was assigned the task of monitering hardware development in the Apollo program to insure that no technical decision would be made that would compromise unnecessarily the possibilities for modification of the hardware to be used in the LLS program. At the same time, he participated as a NASA technical representative in an interagency survey of the Soviet space program. This study revealed how effectively the Russians had built their space program around a few basic systems, and relied on modification of existing systems as their program development strategy. The Russian example suggested a desirable alternative to the typical U.S. pattern of spacecraft technology, which tended to build new systems as each new program goal was defined.

At this point events external to the agency began to press NASA's efforts to plan and start development of a new program of space exploration. As will be described fully in the following chapter, President Johnson, in a letter in January 1964, urged NASA to show him what plans and programs were being developed for the post-Apollo period. This urging set off a long chain of events in the agency, one of the earliest of which was Mueller's assigning Taylor in May 1964 to design a post-Apollo program. Taylor specifically was asked to tie the LLS concepts together with the ideas being developed in the earth-orbit oriented, extended Apollo space station studies, and to designate the whole program Apollo Extensions Systems (AES), which would be an interim follow-on program to Apollo.

By July 14, 1964 Taylor, as director of Special Manned Flight Studies, produced a draft project proposal for an Apollo Logistic Support System (ALSS). The objectives set were camera mapping and geological survey from lunar orbit, and 2-man, 14-day, lunar surface exploration for scientific purposes. The hardware configuration was based on Apollo and conceived explicitly with the ground rule of maximum use of existing equipment in mind. The missions projected would employ the Saturn V, Extended Apollo, CSM, extended LEM's on LEM Trucks, a survey and mapping camera system attached to the CSM, and various lunar "orbit-to-surface" probes and scientific sensors. In addition, a number of hardware innovations were proposed. Among these was an "Orbital Survey Module," to carry two men in a 28-day lunar orbit and to be deployed on the lunar surface as a fixed shelter. Also proposed was a "Molab," a lunar surface vehicle designed to carry two men and scientific equipment on explorations of up to 14 days. With the Molab there would be a Lunar Flying Vehicle that would provide the two crewmen an emergency return to the LEM if needed. New suits for such lunar missions were seen as essential.

The ALSS concepts then were integrated with earth orbital mission ideas, and in August 1964 the Office of Manned Space Flight issued a Proposal for Apollo System Extensions. The proposal stated the objectives added for the earth orbital portion of the program as: "To conduct biomedical, scientific, and technological experiments in near-earth space to support the extended lunar missions and to provide data and operational experience for more extensive earth orbital operations." Major ground rules for the program were flexibility of capabilities and maximum use of existing hardware. The hardware proposed was essentially the same as listed in the draft ALSS study.

Along with the AES proposal was a proposal for "Experiments Support" for the program, especially for earth orbital missions. Although originally described in highly general terms, more specificity was introduced quickly as the program development process continued. By November 1964 the AES team in OMSF had developed a Program Development

Proposal. This document listed in some detail the biomedical and behavioral sensing equipment to be employed; types of experiments for astronomy, bioscience, physics, chemistry and meteorology; earth mapping and resource survey sensors; experiments in communications and navigation; and tests in manned operational capability. It described a great deal of the equipment to be employed for the science and technical experiments. Among these, significantly, was "a modified OAO /Orbiting Astronomical Observatory--developed by the NASA Office of Space Science and Applications/ telescope or a larger . . . telescope with wide/r/ . . . range. A solar chronograph, /and/ a radio telescope."

The next month two further documents carried forward the AES program. The AES Program Definition Guidelines set out an important part of the basic philosophical framework within which the agency was viewing the program:

> A governing ground rule for the AES program is that it is literally an extension of the Apollo program which broadens and extends the capabilities of Apollo hardware to accomplish expanded mission objectives in earth orbit, in lunar orbit and on the lunar surface. As such, it is planned that the AES will merge into Apollo as the program proceeds. Since another governing ground rule is that AES shall not jeopardize the basic lunar landing program, the time at which AES can be integrated with Apollo must await the completion of AES Program Definition and the judgment of NASA management on the readiness of the Apollo program to take on added responsibilities.
>
> Although it has not been formally recognized, one can predict a continuing process of definition of Apollo additions beyond that presently encompassed by AES, as new concepts emerging from the studies of future systems are brought in and "program defined," and new hardware is fed into the Apollo development pipelines.

The other paper was titled the AES Experimenter's Guide; it set out rather elaborate preliminary information on experiment schedules, mission configuration, hardware, design and test criteria, system interfaces, and scientific equipment stowage. The guide listed a variety of lunar missions and described earth orbital missions of extended duration, polar, and synchronous types. It also discussed the possibility of using the LEM for orbital inspection of disabled satellites.

Importantly, two novel concepts of hardware modification for experiments were introduced. One was the proposed use of the SLA (Spacecraft-LEM Adapter) area for stowage of experiments on missions that did not require the LEM; the other was the mounting of experiments in a pallet, using space in the service module, as seen in Figure XI Deployment of experiments was described in highly general terms, however. It was noted that some might be mounted external to the LEM and at "various places throughout the spacecraft." Exact configurations had to await further program definition.

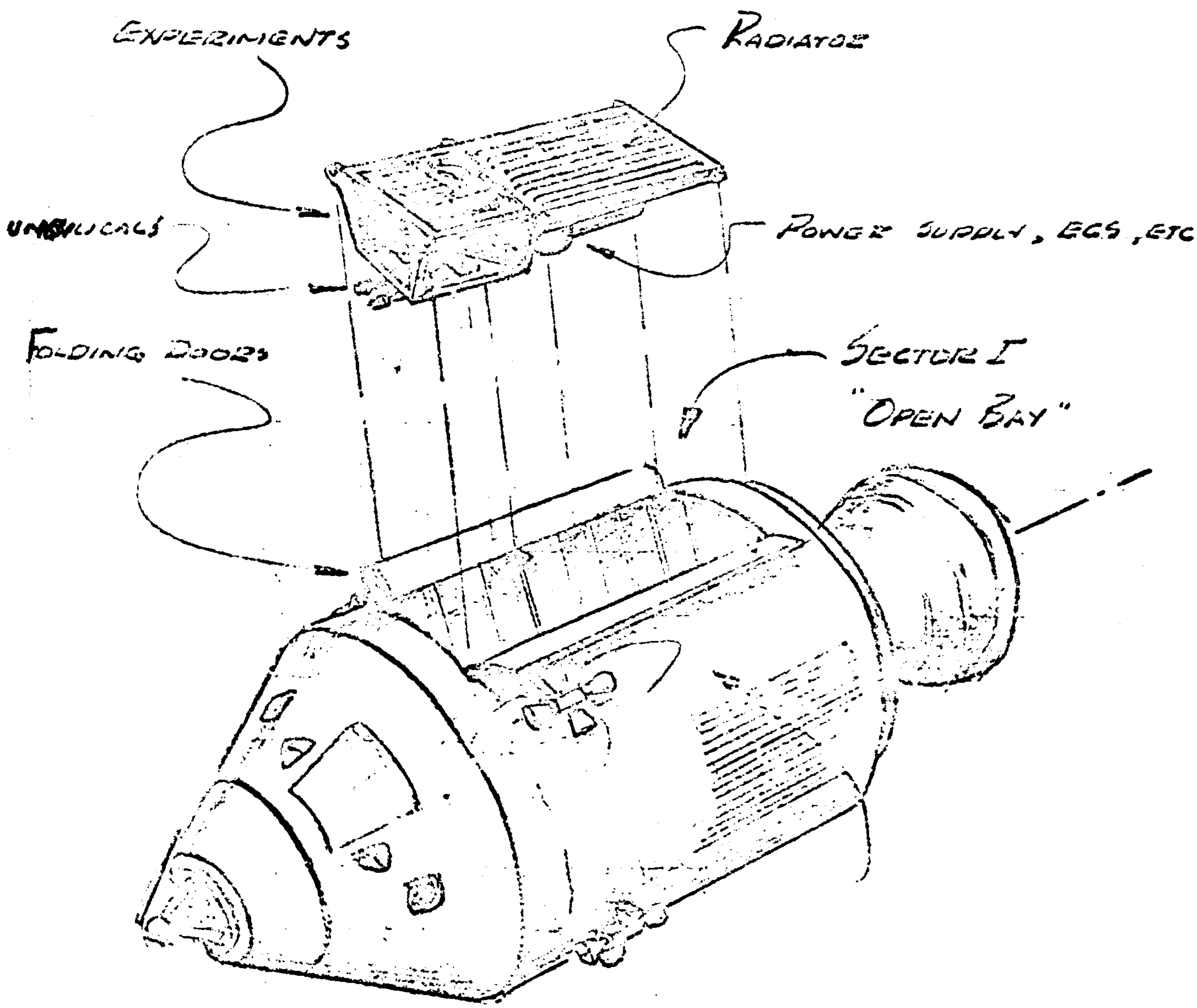
Hence, through the period of May to December 1964, the Apollo Extensions Systems Program was conceived and underwent a swift conceptual development: a development based on long-standing agency thinking about future goals and a large number of "advanced studies," but nonetheless a development marked by imagination and by confidence. The program was conceived at this point as based on extended capability and modified Apollo hardware, with a variety of specialized lunar logistics and exploration craft. Mission objectives, while given some specificity, were still general and highly contingent on further development. Most contingent of all was the experiments spacecraft hardware interface: the only concepts developed were the SLA stowage and pallet ideas, and a "lunar mapping and survey system" carried by the CSM in lunar orbit. The program emphasis clearly was on extended lunar exploration.

By the 1968 budget period, however, the emphasis had shifted to earth orbital operations and the central piece of hardware had become a "wet workshop" constructed in orbit from the spent S-IVB stage of the Saturn booster. To this had been added an "airlock" and a multiple docking adapter that allowed the attachment of an Apollo CSM and a large man-operated solar telescope built into the ascent stage of the LEM. The lunar mapping and survey system and the pallet idea had been dropped, and an earth resources survey module was introduced and then taken out. The experiments development process for the post-Apollo missions also had undergone a great deal of fluctuation. The next chapter will describe what external events impacted on internal technical decisions; the intent here is to describe these decisions from a technical emphasis and indicate how they were resolved within the agency.

The Issue of Future Rocket Propulsion

In addition to the detailed changes in hardware that occurred as the post-Apollo program definition process unfolded, the issue of what pattern was to be followed in the future development of booster rockets arose.

FIGURE XI



AN ILLUSTRATION OF AN EXPERIMENT
SM PALETTE

There is a wide variety of research being done in NASA on advanced rocket propulsion systems.[1] Some is directed at improving and simplifying the existing liquid chemical propulsion technology that is employed in such rockets as the Saturn. A "next step" in the development of chemical rockets is the development of operational techniques for employing more exotic liquid fuels, such as the powerful liquid fluorine, and for utilizing dependable hypergolic fuels, that is, fuels that ignite on contact with one another.

There is much interest also in the development of a large (260 inch) solid propellant booster. Solid fuel rockets burn a fuel that has the oxidizer mixed in; thus, the whole charge can be packed together in the rocket casing, which serves as both a storage and combustion chamber. Because solid propellants do not require the elaborate pumping and valving systems needed to bring together in proper proportions the fuel and oxidizer in the liquid rockets, solid propellant boosters are much less complex. Further, solid propellant boosters theoretically are less expensive than liquid rockets, and they do not present difficult problems of propellant storage. This is especially true in comparison with liquid cryogenic fuels, which must be kept in a super-cold state (-297.4 degrees Fahrenheit for liquid oxygen and -423.04 degrees Fahrenheit for liquid hydrogen) in order to prevent vaporization. However, solid propellant boosters as yet cannot be controlled with the sophistication of liquid rockets, require more thrust for a lifting capacity equivalent to that of liquids, and present many difficult logistic problems.

Other prospective lines of development for future rocket vehicles are based on esoteric principles of nuclear fission, electric propulsion, and light propulsion. NASA, in cooperation with the Atomic Energy Commission, actively has been pursuing nuclear engine development. The initial programs, Project Kiwi and Project Phoebus, are being followed with the NERVA (Nuclear Engine for Rocket Vehicle Application) program. Nuclear rockets operate by utilizing the tremendous heat produced by the fission process in nuclear reactors to heat a liquid--hydrogen, helium, or ammonia--which then is channeled with enormous velocity through a nozzle. A NERVA system was ground tested successfully early in 1966.

The "photon rocket," which would operate on the pressure exerted by light, is only speculative at this point, but there are a variety of electric propulsion systems that have been given more specific

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[1] The facts presented here for the review of rocket technology research were taken for the most part from Chapter XII of Space: The New Frontier, NASA Educational-Information Book (Washington, D.C.: U.S. Government Printing Office, 1967).

definition. The "ion engine" operates by electrically accelerating charged atomic particles through the rocket nozzle. Very little thrust is produced, but fuel consumption is low, the rockets are light, and they easily can be started and restarted. With the "arc-jet" version of the electric rocket the fuel is converted into a propellant gas, not through the use of an oxidizer, but by passing it through a high temperature electric arc. Theoretically, the power of this engine is far greater than that of any known chemical or nuclear system. Another version of this principle is seen in the "resisto-jet," where the fuel is heated by an electrically heated wire or tube (as in a household toaster). The plasma accelerator engine can attain much greater specific impulse than other rockets by heating a propellant that ionizes easily and then magnetically accelerating the "plasma" that is created. One major problem in making these electric propulsion systems operational is developing a means of producing sufficient electrical power from sunlight, although this is only one power source.

The options, emphases, and priorities involved in future booster developments of the types just described figured importantly in the political system's consideration of the post-Apollo space program, as will be seen in detail in the later chapters. However, there were decisions taken of lesser scope and more technical nature that produced important repercussions within the agency. These decisions related specifically to what pattern would be followed in the further development of the Saturn boosters.

The post-Apollo program was given an organizational reality in May 1965, and in August officially was established as the Saturn-Apollo Applications Office under an acting director, David M. Jones. Administrator Webb had rejected as politically imprudent the "Apollo Extensions Systems" rubric favored by Office of Manned Space Flight Director George Mueller. Webb felt that the emphasis in the program's image should be utilization of the Apollo capability rather than extended development of the Apollo program, of which some members in both houses of Congress were becoming skeptical. The SAAP (soon called AAP) office had two main sections: Saturn Applications, headed by Colonel Harold Russell (USAF), and Apollo Applications, directed by William Taylor.

The initial task of the Saturn Applications group was developing the Saturn IB booster with a Centaur upper stage for use primarily in unmanned space science programs. In particular, mission planners in OSSA viewed the Saturn IB/Centaur booster as the vehicle for planetary space probe missions, first to Mars and then to other planets. In August 1965 hearings on post-Apollo goals were held in the Senate; at these hearings OSSA Associate Administrator Homer Newell described Project Voyager as a new unmanned planetary exploration program. He noted that the program was still in the design definition stage, but that the Saturn IB/Centaur was the proposed launch vehicle. The spacecraft system would have a planetary orbit capability rather than the simple "flyby" mode of the Mariner planetary craft; in addition, it would be capable of entry and landing on Mars. The insertion of the Centaur stage on the Saturn IB represented an incremental step in the development of planetary space probe boosters that would lift the 2,300 pound escape payload weight limitation imposed on planetary missions by the Atlas/Centaur booster then being planned for the Mariner series of planetary spacecraft. With the S-IB/Centaur, an escape payload of 13,000 pounds was possible. The Marshall Center was assigned responsibility for this booster development; JPL was given responsibility for the Voyager project. Marshall, as a matter of engineering challenge, was not really interested in working on the Centaur stage, however; eventually this work was transferred to the Lewis Center.

Planning work involving the S-IB/Centaur-Voyager proceeded rapidly after establishment of the SAAP office in May. A vehicle status review meeting was held in June; early in July a Saturn IB/Centaur-Voyager Interface Panel met at NASA's JPL Center. In addition, during this same period at least ten technical and management meetings were held by project personnel at the participating centers.

The direction of the Voyager program changed quickly, however. Data returned from Mariner IV indicated that the Martian atmosphere was much thinner than had been predicted. This fact held serious implications for the Voyager spacecraft design, since its landing capability originally was conceptualized in terms of the parachute principle. In the preliminary design of hardware landing devices appropriate to the thin Martian atmosphere, spacecraft weight increased to such an extent that the payload capability of the Saturn IB/Centaur booster for launching the craft was brought into question. Exactly what decision premises entered the picture when the S-IB/Centaur payload capability question arose is not clear. To a number of the participants in OSSA, it appeared that George Mueller and the OMSF organization played a decisive role. OMSF argued that for the long run, the Saturn V booster would be the most flexible, "most stable," and available; that it would save on development costs; and that planetary missions should be planned on the basis of its use. OMSF further argued that two Saturn IB's required for Voyager missions cost as much as one Saturn V.

At any rate, on October 20, Colonel Russell wired the participating NASA centers that "Recent Voyager program redirection deletes . . . use of the Saturn IB/Centaur as the launch vehicle." The "redirection" that occurred was a doubling of the size of the Voyager payload so that two Voyagers could be carried. Four spacecraft were involved, two orbiting craft and two landing craft; all could be launched on a Saturn V booster. As will be seen in detail later, this decision brought a severe reaction from the political system. PSAC evaluated the program as having a "mismatch of payload with booster." When Voyager was presented in the 1968 congressional budget hearings, all funds requested for the program were cut by the Senate committee and it received no appropriation.

While to Mueller and OMSF, the decision to place Voyager on the Saturn V was "a decision of NASA as an agency" and was based on purely technical grounds, a great amount of emotion and a good deal of suspicion about OMSF motives were created in OSSA. OSSA planners viewed the S-IB/Centaur capability as marginal, but saw many advantages to use of this booster that helped offset the weight penalty and implied redesign of the spacecraft to a lighter weight. As a general premise they felt that smaller launch vehicles were "the logical next step" and that the program would have sold better politically if the Saturn IB/Centaur booster had been used. Further, OSSA denied as non-factual the argument that two S-IB's cost the same as a Saturn V. Its view was that, with the S-IB mission, flexibility would have been much greater; a more rational, evolutionary approach could have been used; and testing would have been much easier. OSSA personnel, moreover, believed that OMSF's desire to use the powerful Saturn V for Voyager was dictated by interest in making Voyager a "camel's nose in the tent" for a manned planetary program--a view shared, as will be seen in Chapter VI, by some members of Congress. There was general agreement that a large part of the divergence in perspective between the two offices resulted from lack of coordination and integration of the planning effort going on in each. Many OSSA people felt that OMSF had developed a plan for manned planetary missions that subsumed such OSSA activities as Voyager and made them simply a part of the manned effort rather than a space science operation, and that it was OSSA that suffered the political consequences. This feeling undoubtedly stemmed from the fact that OMSF developed a plan for a "Manned Voyager" Mars flyby mission and presented this plan to the President's Science Advisory Committee in 1966.

It appeared clear that utilization of the Saturn V booster was a preeminent policy imperative in NASA's post-Apollo thinking about booster capability.

The "Wet Workshop" Issue

The discussion of the booster development issue introduces an important element that operated throughout the process of making the most crucial decisions in the post-Apollo program, namely, the perspective of George Mueller, Associate Administrator of the Office of Manned Space Flight in NASA. Mueller's background, as was pointed out in Chapter II was technical and academic. He came to NASA in the fall of 1963 from Ohio State University, Bell Telephone Laboratories, and five years with Space Technology Laboratories. This background influenced Mueller's policy position in his NASA role in a number of important ways, one of the more significant of which was his introduction into manned flight operations of the "all up" testing concept with which he was familiar from his work in development of unmanned spacecraft.

This concept was based on the principle of testing all components of a mission system at one time and in flight with an operational payload rather than one by one on a "breadboard" in extensive ground tests. While there was widespread skepticism in NASA when Mueller introduced this test method, it quickly was proved to be a highly desirable innovation in that it greatly cut hardware development costs. Hence this technique was politically attractive on this important count, and in addition was a foil to outside criticism that had occurred over the launching of rockets with sand ballast payloads in test flights. One important result was to produce high respect for Mueller's competence, which further raised the stature he enjoyed as head of OMSF. A by-product of this technique in regard to the Apollo program was to create an even larger surplus of hardware than had been expected from the "buffer" of extra components that had been built into Apollo in case difficulties developed.

The structure of Mueller's role in NASA also produced impacts on the context in which post-Apollo decisions were taken. Because authority for technical direction of the Apollo program was vested in a "Program Manager" and because there was expert competence for technical review above Mueller in the person of Seamans, Mueller naturally turned in his role to the agency-environment interface and to the general management problem of maintaining and adding to the complex NASA industry structure that formed the manned space flight capability. This first-mentioned activity was best exampled in such things as Mueller's development of the "manned space family," with the Field Center Development Office, and his creation of STAC, both described in Chapter II. The second type of activity--maintaining the industry structure--can be seen in the perspective that Mueller brought to the post-Apollo program development. Mueller saw that close direction of post-Apollo plans was essential to meeting his general management responsibilities to the manned flight program; after Gemini was completed, he worked with E. Z. Gray in the Office of Advanced Manned Missions and played a large part in defining this program. As such, Mueller served as the focal point through which external contextual factors and internal management considerations came into play in the process of developing technical options and taking technical choices. Mueller's initial concern for the post-Apollo program was to develop mission concepts oriented to the level of work problem in the industry-contractor base that had been geared up for Apollo. It soon became apparent to him, however, that a more urgent primary problem was maintaining work load balance and adequate technical competence at NASA's own manned flight field centers. This type of concern was evidenced most strikingly in his early insistence on an annual "6-6-8" launch rate (6 Saturn IB's, 6 Saturn V's and 8 Apollo CSM's) as the framework within which the post-Apollo program would be set. Although much of his organization regarded such a schedule as completely infeasible, Mueller's general management perspective told him that the economics of space technology and organizational reality demanded that such a rate be aimed at.

Working from this perspective, Mueller was a decisive influence in the major decision about what configuration would be employed for the first earth orbital space station to follow Apollo. The options involved in this decision were straightforward. The earliest concept and the one with the greatest support at the Houston MSC was for a laboratory/space station built into the SLA area of the Saturn/Apollo vehicle with the crew in the CSM. This laboratory concept was drawn in both a "dependent" mode (supplied off the CSM systems for three-four months) and an "independent" mode (in which its own systems would provide supplies for one year) as shown in Figures XII and XIII. This laboratory would have provided a capacity of 5,600 cubic feet and room for about six men. Preliminary studies of this idea recommended it highly and Houston planners urged the idea to Mueller. Mueller reacted negatively, however; he argued that the capacity of the laboratory was too large and too demanding on the environmental control system. As an alternative, he directed the Houston Center to study an "experiment can" concept, wherein one or two specific purpose laboratory modules would be fitted into the SLA area and flown with the CSM systems, as shown in the illustrations on the following pages.

These concepts, and others for larger space stations, were presented at an Associate Administrators Advanced Study Review of earth orbital studies in June 1964. During this same fiscal year a study conducted by North American Aviation and monitored by the Marshall Center was funded for the purpose of assessing the economic and technical feasibility of using spent, orbited upper stages of the Titan III, Saturn IB, and Saturn V as sources of usable subsystems or additional living space for crew. This study determined that the Saturn IVB upper stage offered technical and strategic advantages in this regard. As a result, two additional studies were funded: one for the development of a "Spent Stage Environmental Support Module" (SSESM) and a second to examine the concept of outfitting the S-IVB stage "on the ground" and launching it in a prepared state for earth orbital laboratory or space station operations.

The concept of utilizing a spent rocket stage as an orbital spacecraft-workshop is widely attributed in the agency to Wernher Von

FIGURE XII

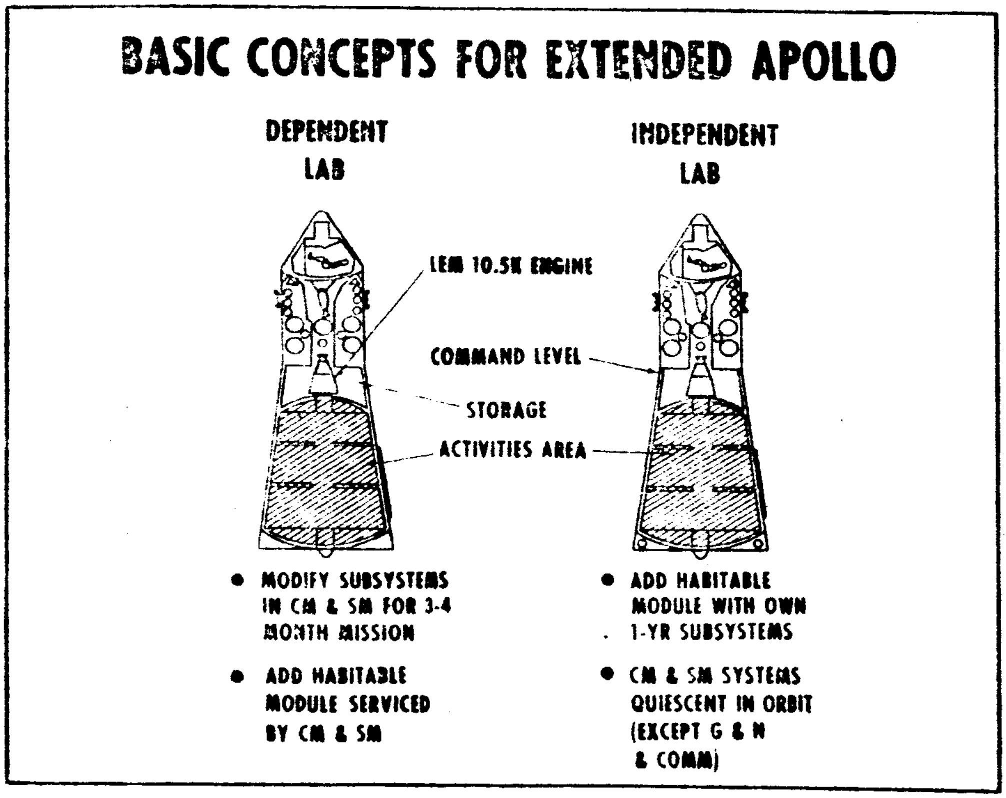
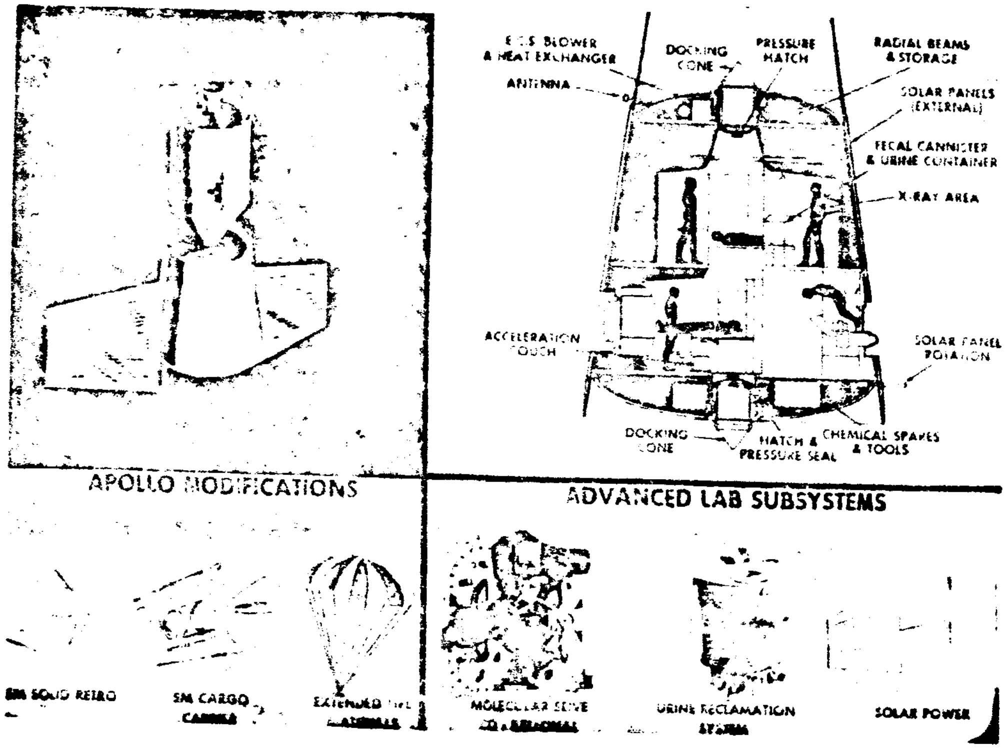
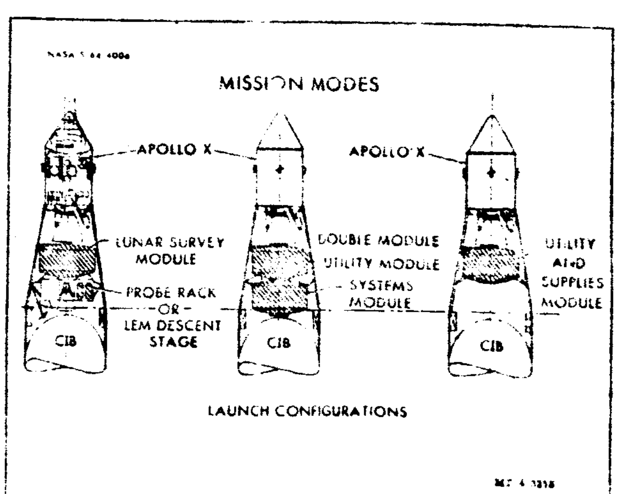

BASIC CONCEPTS FOR EXTENDED APOLLO
DEPENDENT LAB
INDEPENDENT LAB
LEM 10.5K ENGINE
COMMAND LEVEL
STORAGE
ACTIVITIES AREA
• MODIFY SUBSYSTEMS IN CM & SM FOR 3-4 MONTH MISSION
• ADD HABITABLE MODULE SERVICED BY CM & SM
• ADD HABITABLE MODULE WITH OWN 1-YR SUBSYSTEMS
• CM & SM SYSTEMS QUIESCENT IN ORBIT (EXCEPT G & N & COMM)

FIGURE XIII

EXTENDED APOLLO





Braun. At first Von Braun saw the spent stage laboratory as an "experiment" in the post-Apollo program: a crew would rendezvous with the stage in an Apollo CSM, and then would engage in extravehicular activities that would determine whether residual fuel vapors could be vented so as to make the stage habitable, and in general whether the structural integrity of the stage had been maintained enough through the launch process to make it usable. As the spent S-IVB stage studies progressed, however, thinking shifted toward the concept of building floors, wiring, and other basic crew facilities into the tank before it was filled with fuel, and of installing an easily removable hatch for crew entry after rendezvous. The stage then would be fueled, used normally in the launch process, and utilized as a workshop in its natural earth orbit. Because the stage served both as a fueled propulsion unit and as an orbital workshop, the term "wet workshop" was used to describe it. By adding expendable supplies in the SSESM to the workshop, extended duration earth orbital missions seemed feasible and economically attainable--missions that could answer some of the basic questions still remaining about biomedical and behavioral aspects of relatively long space missions.

As the technical conceptualization of the program unfolded, concepts from a variety of the advanced manned mission studies were incorporated into the wet workshop plans. One study used was directed at the problem of CM costs. A method was conceptualized for refurbishing and for components replacement of used Apollo CM's. This study provided reuse cost information and set out measures for incorporating anti-corrosion techniques in the CM's. This information was provided both for CM reuse and for use as a minimum cost laboratory; the reuse concept was incorporated directly into the program.

The SSESM concept was incorporated as an airlock module (AM) connected to the upper end of the S-IVB stage on a truss framework attached at the same points where the LEM is attached during launch. The airlock was designed to contain consumables, umbilicals, and experiment packages. Also included was a "structural transition section" or tunnel assembly, with two hatched internal bulkheads and a pressure-tight assembly connected to the top of the S-IVB tank. This tunnel permitted intravehicular transfer for the crew in a pressurized environment and served as an airlock for extravehicular activity using a Gemini hatch.

From the "multipurpose mission module" studies (the "experiment can" idea described earlier) a backup concept was derived and utilized with the wet workshop. This concept, termed the "multiple docking adapter" (MDA), was a piece of hardware designed to be mated physically to the SM before launch. The original concept for the MDA contained only one docking port, for a CSM, but it ultimately was expanded to include five docking ports: three CSM ports and two for LEM docking.

This group of hardware, along with a docked CSM, is shown in orbital flight configuration in the illustration on the following page.

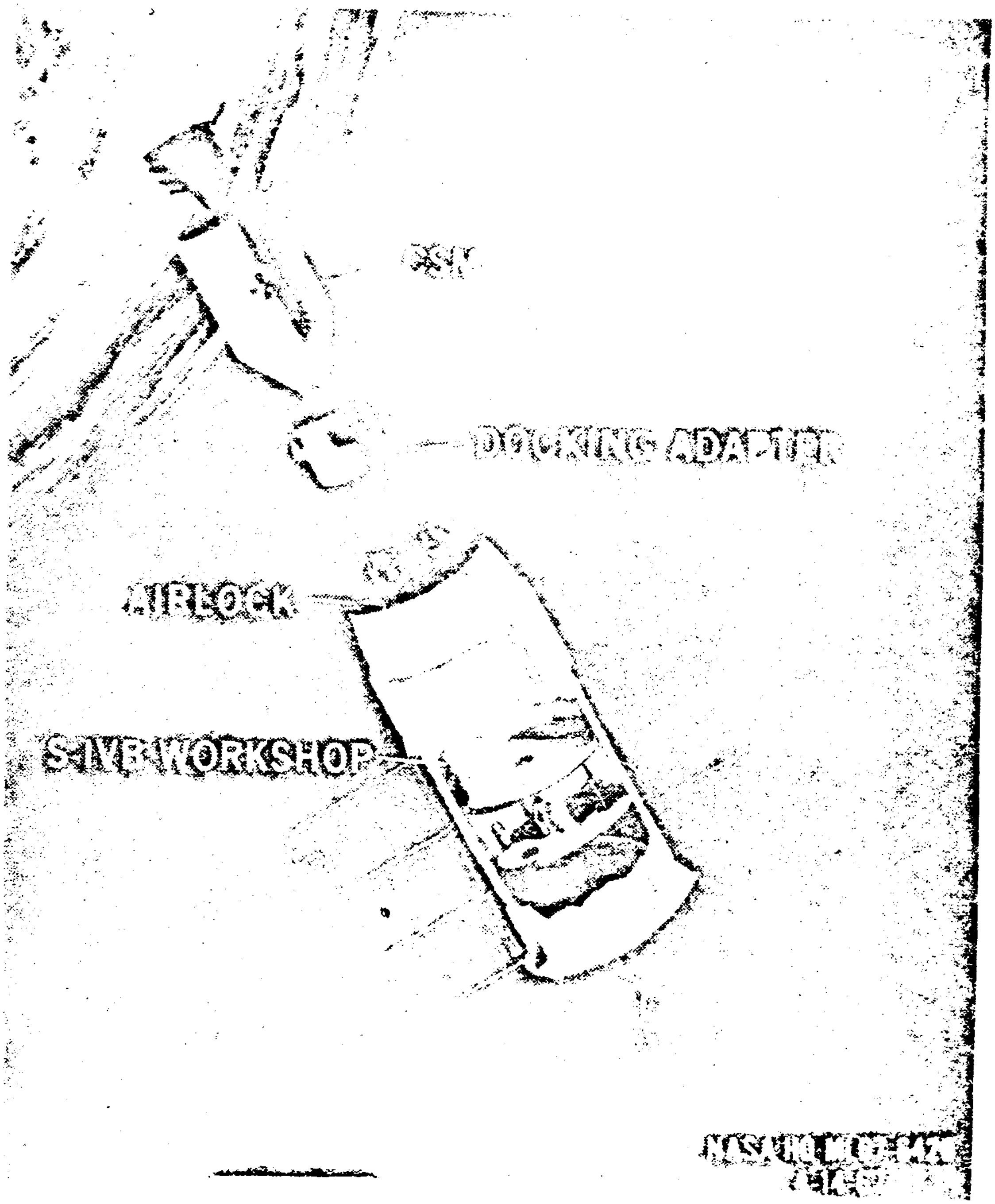
The SLA laboratory originally studied and proposed by the Houston Center offered a volume of 5,600 cubic feet. The S-IVB workshop gave almost twice this amount of space: 10,460 cubic feet. Because Mueller had objected to the SLA laboratory concept as being too large, the planning group at the Houston Center were taken aback when he announced his strong support for the S-IVB wet workshop idea. The Houston engineers felt that their SLA laboratory concept was far superior in technical terms to the huge S-IVB stage plan; the latter posed, to them, serious technical problems of fuel venting, oxygen leakage once pressurized (since the exact condition of the tank after orbit was not known), and astronaut fatigue in carrying out the great amount of extravehicular activity required to outfit the stage as a livable workshop. Speculation arose among the Houston group that Mueller was making his decisions in light of the political factors that were beginning to emerge: resources were becoming more scarce and "anything that looked like duplication or a new start was going to be axed." In this regard, the Houston engineers noted that the SLA laboratory concept appeared very similar in physical shape to the Manned Orbiting Laboratory being developed by the Air Force, which was cylindrical and flew in back of the command module (in this case a Gemini capsule) just as the SLA laboratory would. Compared to the S-IVB wet workshop, the SLA laboratory did appear to be more a "new start" toward a space station program than a "workshop" that would answer basic biomedical and other questions that needed answering before the feasibility of various space station ideas could be assessed.

The "Experiment Can" and the "LEM Laboratory"

An earlier issue, which arose in 1965 and was closely related to the basic question of the S-IVB versus an SLA laboratory or similar configuration, was the manner in which the S-IVB would be supplemented and equipped as a working laboratory with experiments and proper human environment. The Houston Center had definite preferences as to how experiment modules should be designed. Engineers at Houston, led by William Stoney, long had favored specific purpose or specialized hardware for orbiting laboratories, and revived a can concept developed for possible use as a docking target in the Gemini program. Their approach to space station design had tended toward the "modular" concept, in which specific purpose modules were connected to form a station. A 15-foot-diameter, space station module concept was developed in a 1964 Houston-monitored study carried out by Lockheed Aircraft. This was supplemented by later studies at General Dynamics, Douglas, Boeing, and the Langley Center. To the Houston engineers there was convincing

FIGURE XIIIA

ORBITAL CONFIGURATION



philosophical and technical evidence that the best approach was specific purpose modules or "cans," such as the one described earlier as riding in single or double configuration in the SLA area.

When the question of S-IVB supplementation was addressed, however, a number of contending alternatives emerged: the Houston "can" concept, the modified LEM (an approach introduced by Mueller), Gemini systems (ultimately employed by the Air Force in its MOL program), and the existing but as yet unadopted airlock/rack idea described in the preceding section. Mueller's concept was to strip out the LEM so as to provide space for supplies and experiments and dock it into the S-IVB stage as a "LEM Lab." Studies of these approaches were carried out and, according to the Houston view, a clear ranking of three main alternatives resulted: the "can" approach was best, the airlock/rack the second best, and the LEM Laboratory the least desirable. To Houston, the LEM approach was completely infeasible: it provided only cramped quarters and the modifications required would have made the approach the most costly of all the alternatives. Hence, the Houston engineers "were startled and had absolutely no sympathy" when Mueller kept insisting to them that the LEM should be utilized in the S-IVB workshop configuration.

Finally, at a meeting in Houston between Mueller and the spacecraft engineers, Joe Shea, head of spacecraft development, asked Mueller directly why he was pushing the LEM approach in spite of its obviously weak technical recommendations. Shea asked Mueller if the real reasons for his position were not "partly political;" Mueller replied that his motives "were not partly political but completely political."

The Solar Telescope Location Issue

The idea of a solar telescope experiment for advanced observation of solar phenomena was brought into post-Apollo thinking at the early planning stages. NASA's OSSA had flown an automated solar telescope satellite (the Orbiting Solar Observatory) with some success, but because the telescope involved possessed only limited resolution power, there was a great deal of interest among astronomers in the development of a more sophisticated instrument. This led OSSA, through the Goddard Space Flight Center as its leading astronomical research facility, into the development of a second generation solar telescope, the Advanced Orbiting Solar Observatory (AOSO). The contractor most involved in this development was Ball Brothers Research Company. Development proceeded but when funds became scarce OSSA decided to drop the AOSO program.

Through this same period, OMSF planners were attempting to develop a use for the pallet or "experiments bay" that they had designed into the modified Apollo CSM for use in post-Apollo missions. One concept that emerged was to mount the Lunar Mapping and Survey System in this area. This idea was rejected, however, in favor of docking this camera system to the CM docking port. Then the idea of placing the AOSO telescope system on the Apollo SM, either in the pallet, or as later conceived, on a "pod" outside it, was advanced. Exactly what was the source of this proposal was not clear, but the OSSA version of its history was that it grew out of interactions with and study by the Ball Brothers laboratory. The SM concept was highly attractive to OSSA mission planners and was endorsed by Homer Newell, the OSSA Associate Administrator. Hardware development proceeded; the CSM/telescope (called the "Apollo Telescope Mount" or "ATM")concept was given a specific design configuration. Mueller in OMSF then generated and offered an alternative concept for flying the ATM. Because of technical problems that he saw emerging as specific designs were developed for the CSM/ATM concept, Mueller proposed building an expanded ATM using the ascent stage of the LEM as the crew operating station. His first idea along this line was to attach the ATM to the workshop by means of a flexible tether that carried power and life support. Von Braun enthusiastically endorsed this idea. Ultimately, however, Mueller arrived at the view that the ATM should be attached, "hand mounted," to what turned out to be the multiple docking adapter.

As these events unfolded, rather clear perceptions of various types of stakes came into focus in the agency among people who were involved in the decision process. On the one hand there was a set of stakes perceived as being focused in OSSA and OMSF as organizational units. Coordination and communication between OSSA and OMSF were poor; as a result, there was a good deal of competitive feeling extant, focused on the idea that "future control" of NASA's astronomy activities was at least partially at issue. This feeling was both exacerbated and complicated by the fact that management responsibilities would be allocated differently under each of the two hardware options. With the CSM/ATM alternative, hardware development would be controlled or monitored by OSSA's Goddard Center in coordination with Houston so as to handle the telescope-spacecraft interface problem. Related to this was Goddard's continuing effort to strengthen its astronomy capability and in general to optimize its relationship to the astronomy community.

On the OMSF side, there was increasing interest in a solution to the extremely difficult problem of payload or experiment development for manned flight missions. In addition, Mueller had proposed that if his LEM/ATM concept were the one selected for development, the Marshall Center be given the management and work responsibility for the LEM/ATM integration effort, that is, the actual work would be done "in-house" at Marshall rather than by a contractor and at a saving in R&D expenditure.

A critical place at which the issue of where to locate the ATM was aired fully was in an Apollo Applications Status Review meeting held before Deputy Administrator Seamans on April 8, 1966. At this meeting, all aspects of the two options were considered. The CSM/ATM concept was argued to have many advantages: (1) greater mission duration; (2) greater confidence in schedule; (3) greater flight experience with the CSM; (4) fewer, less risky launch time modifications required; (5) less water dump problem; (6) less total cost per mission. The biggest advantages of this option were greater shielding requirements and the fact that the ATM operational life would be limited to single CM mission life.

With the LEM/ATM concept, distinctive advantages were seen as its "growth potential" and the possibility of reuse of the ATM. There was serious concern expressed about the facts that no flight and technical background existed for the LEM and that it could not fly without the CSM, which made it more expensive and gave it less operational time. Also, while both CSM and LEM development schedules were lagging, there was a consensus that the LEM option would result in a later start for the program. The OSSA conclusion was straightforward: the CSM approach was most feasible and preferred.

After the technical presentation, Mueller and Newell each stated their positions. Mueller noted that while two of the organizations involved favored the CM approach (OSSA preferred the SM-pod, Houston the SM-pallet), the AAP office in OMSF favored the LEM/ATM approach because it would avoid duplicate work later and fit the FY 1967 fund shortage. Mueller noted that he had discussed the location issue with Von Braun and had found that an "impressive potential capability for ATM development" would be available at the Marshall Center in the time period when ATM was to be developed. He argued that the "hard mount" of the telescope on the LEM laboratory was technically clean, offered more communications flexibility, provided crew pointing rather than automated pointing, and would reduce integration problems between Goddard and Marshall by giving more responsibility to Marshall. Significantly, Mueller noted that the basic question at issue was future utilization of the LEM in space missions. If used as the mount for the ATM, the modifications executed would make it useful for a larger set of AAP missions.

Newell's comments were brief and reflected a purely scientific perspective on the issue. He said OSSA recommended the CSM for the "timing and simplicity of the job," and "from the scientific viewpoint, it is extremely important to cover the solar maximum in '67 through '69 with the ATM." He further noted that "delays can be foreseen at this time with the LEM" and there was some question about holding the highly accurate pointing tolerances required for ATM operations.

Seamans concluded the meeting with the observation that "there is more to making the decision on ATM spacecraft location than technical and scientific considerations." As he saw the options, they were: (1) select CSM and meet the schedule, or (2) select LEM at greater cost in money and time but at the gain of "eventual growth potential." Seamans further noted that it was important to maintain "enthusiasm for use of the Apollo hardware." At the conclusion of the meeting, Seamans asked Mueller and Newell to prepare a more detailed analysis of the options for presentation to him in "an executive session of principals only" on April 14.

To Mueller's view, there were definitely organizational stakes, of the sort described earlier, involved in the decision. He has reported in retrospect that "I am sure there was some disappointment when MSFC got the ATM. Goddard wanted to get in on the CSM so they could have developed it. They did not want to share the work." On the other hand, the parties most intimately involved with execution of the project saw the issue in more technical terms. Ernst Stuhlinger, head of the Space Science Laboratory at Marshall and hence in immediate charge of the LEM/ATM project, saw relations with the Goddard Center as involving stakes and competition but as being resolved ultimately by the technical capabilities of the two organizations. The Goddard Center wanted the project very much but had some doubt that it had the capability for building the large mechanical structures involved--a capability in which the Marshall Center was exceptionally strong.

The issue remained unresolved. Other alternatives and variations, including mounting the ATM on the airlock, were considered briefly. Some progress was made in fixing the AAP hardware configuration and in allocating organizational responsibility for its development, however. An agreement on MSC-MSFC roles and missions in AAP was reached at an OMSF Management Council Retreat at Lake Logan, North Carolina, in the middle of August 1966. At this meeting, discussion and consensus were focused through use of a modular space station concept as an intermediate milestone to later planetary missions. Any space station was seen to consist of a command post module, a mission module, and one or more experiment modes. General principles were formulated for defining various mission tasks into the modular categories. All command module work was allocated to Houston, all mission module work to Marshall, and experiment modules to both Houston and Marshall. The S-IVB workshop was defined as a mission module and given to Marshall. The ATM question was left open, however.

The Experiments Program Problem

The general march of events and prevailing conditions in the development of the post-Apollo program set a framework within which the development of "payloads" or experiment packages for specific missions became extremely difficult. The "6-6-8" annual launch capacity with launches scheduled to begin in mid-1968 was a basic factor in creating pressure for an accelerated payload development effort. This scheduling assumption stimulated "wildly speculative and optimistic thinking" by payload planners--although Mueller felt that the major problem in development of payloads was "lack of imagination." There was a general consensus, however, among virtually all the people involved in AAP planning and development that the process of creating experiment payloads for these missions was the most problematic aspect of the program.

As with all the technical issues involved in post-Apollo, the background of events played an important role in the development of an experiments program. Earlier it was noted that the Space Science Board of the National Academy of Sciences had conducted science planning conferences in cooperation with NASA. Two such study meetings formed an important element in this background. The first such study was held at the University of Iowa in 1962; its results were published as A Review of Space Research.2/ Perhaps the strongest recommendation resulting from the study was that ". . . finding and exploring extraterrestrial life should be acclaimed as the top priority scientific goal of our space program." The start of plans for a manned exploration of Mars also was recommended, and in general the report expressed the desire that the scientific community play a more substantial role in the manned space flight program. Overall, the report constituted an endorsement of NASA; the agency, in turn, responded favorably to it. The space agency noted that 63 percent of the report's recommendations were included in NASA's planning and thinking, and that NASA was willing to accept in principle an additional 17 percent. Just 5 percent of the total number of proposals were deemed ". . . inherently unsuitable for . . . [NASA's] current program and its long range thinking."3/

2/ National Academy of Sciences-National Research Council, A Review of Space Research, Publication 1079 (Washington, D.C., 1962).

3/ Charles M. Atkins, NASA and the Space Science Board of the National Academy of Sciences, (A Comment Draft), NASA Historical Note, September 1966, p. 54.

The second study, held at Woods Hole, Massachusetts in 1965, was oriented specifically toward the post-Apollo period and did not yield results so felicitously congruent with NASA's own thinking as the first.4/ The report's recommendations included proposals for large orbiting telescopes, an orbiting research facility, and utilization of ground-based observations and experiments. It noted that the manned-unmanned program distinction was artificial and that scientific objectives should be the paramount, determining factor in setting mission configuration; it concluded that planetary exploration was the most rewarding scientific objective for the post-Apollo period. These conclusions, however, were drawn at a time when resources were becoming scarce, domestic problems were mounting, and thus political considerations of "payoff" were moving to the forefront of budgetary thinking. NASA's reaction, while acknowledging value in the study, was equivocal. A NASA report noted that "the level of effort recommended by the report is too high in a given area with respect to the rest of the program or where we are unable to support the level recommended because of budget constraints."5/ Homer Newell, head of NASA's Office of Space Science and Applications, agreed that "the research outlined in the reports should be done, [but] NASA cannot at this time, undertake more than a small fraction of the new projects outlined."6/

The divergence in outlook between NASA and the community of space scientists bespoke some of the difficulty NASA would have in reaching closure on experiments payloads for post-Apollo missions.

This process of payload development began for the most part with the publication of an official NASA announcement to the science community of Opportunities for Participation in Space Flight Investigations in July 1965. While this document was issued by OSSA, it included at the end a description of experiment opportunities for the manned space science program. It listed five categories of mission: Apollo Earth-

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4/ National Academy of Sciences-National Research Council, Space Research--Directions for the Future, Publication 1403 (Washington, D. C., 1966).

5/ Atkins, p. 57.

6/ Ibid.

orbital, Extended Apollo Earth-orbital, Apollo Manned Lunar Landings, Extended Apollo Manned Lunar-orbital, and Extended Apollo Manned Lunar Surface missions. General descriptions of mission configurations, spacecraft characteristics, and the scientific objectives were presented. This announcement later was supplemented by personal visits and public speeches by payload development division personnel in the Advanced Manned Missions Office of OMSF to stimulate interest in the missions among scientists at universities, in other government agencies, and in private research labs. In addition, background study was carried out in the Advanced Manned Missions Office. These studies investigated problems of measurement of basic biomedical factors in space stations operations, defined initial S-IVB workshop engineering experiments, identified common equipment requirements for experiments, defined and assessed initial space station experiments definition and assessments, and identified sensors to be used in early AAP missions.

Conditions and events intervened in such a way as to prevent the smooth incorporation of the scientists' responses into the program, however. One major difficulty stemmed from the fact that the program would employ the standardized Apollo hardware--modified, but standard nonetheless--for these new purposes. Hence, planners were faced with the task of converting this hardware into general purpose "trucks" that could carry as yet unspecified payloads. To the payload developers this method of development was an extremely problematic placing of the cart before the horse, since space science experiment cargo is unlike conventional freight. In placing a set of experiments in a standardized cargo area such as the SM pallet or inside the CM, a complicated array of sensitive subsystem interfaces was created in regard to inter-experiment relationships and between various experiments and the subsystems of the spacecraft and internal environment. This interface problem was a great obstacle in payload development.

A related technical difficulty stemmed from the fact that the AAP program remained throughout its development in a highly fluid state, without objectives ever being firmly decided upon. Emphasis in goals very quickly shifted, as seen earlier, from lunar to earth orbital operations, and was accentuated as "earth looking" activities such as resources survey came into ascendance in the agency's thinking. This change marked a basic policy reorientation, since in early thinking about AAP missions the primary objective always was conceived as being the demonstration and/or development of a manned flight capability with the Apollo hardware, and experimentation a "secondary objective."

These moves in goal orientation were a result of the increasing uncertainty about the political context within which the program would be sold. Not only did expectations about the type of program shift, but ideas about the level of program that could be predicted changed as it became increasingly clear that funds were getting tighter and tighter.

At first these changes in orientation were rather mild, but ultimately they achieved the nature of a rapid oscillation to where, at one point in the preparation of the FY 1968 budget, the AAP office was formulating up to two or three general program level options per day. Under conditions of such rapid fluctuation, experiment assignments became uncertain and were shifted constantly. With each shift, a new set of hardware interface problems was created, in which, for example, a radiation experiment might be juxtaposed with an experiment requiring shielding from radiation. Under these conditions maintaining the development schedule became virtually impossible. Each delay that was encountered, either from an individual investigator or in the program generally, set off a chain reaction of modifications intended to improve or further insure the performance of the experiment; with modifications, new interface problems were created. The lack of funds suffered by the experiment program also hindered it, in that it was not possible to provide "backup" experiments for those that were dropped or whose investigator quit the program. New experiments, sometimes of a different type and hence creating interface complications, had to be brought in.

There also was some feeling in the agency that basic management difficulties plagued the experiment program, particularly in regard to the lack of communication and coordination with OSSA. It became clear in the management reviews of the program that organizational difficulties were badly hindering the payload development process, and that experiment payload was the critical pacing item for the AAP. In a General Dynamics evaluation study published in December 1965, experiments development was identified as a "critical problem area." Specifically, the report noted that the experiment development plan and launch schedule were inconsistent, and that gaps in Saturn-Apollo hardware might result. Inconsistency also was found in the preliminary experiment groupings: crew time required for experiments in one case was 2,300 man-hours while actual available crew time for the mission was 1,012. In another case an incorrect orbit had been programmed for a mission's photographic phase. The study also pointed out that the entire development schedule for the AAP appeared infeasible unless corrective measures were taken.

One difficulty that was beginning to appear at this point was a set of technical problems involved in using the LEM as an AAP laboratory module. Its payload capacity in synchronous orbit was found to be marginal; even the minor laboratory modifications required seemed undesirable. There appeared to be a lack of time for integration work at the launch site as well as a loading problem at the Kennedy facility, in addition to the fact that the LEM itself was turning out to be too costly for the experiments that would be available.

A report on the experiments' program progress to Deputy Administrator Seamans at an AAP review meeting in March 1966 indicated the scope of the problem. By that date, 218 experiments were under consideration for AAP (as opposed to 49 for Gemini and 33 for Apollo). However, only two had been approved and started on the actual development process. At this meeting, Mueller noted that OMSF was viewing lead time for new AAP experiments as a serious enough problem that it was considering, with OSSA, redoing some of the basic Apollo experiments for inclusion in AAP flights.

On March 30, in a memorandum to all Associate Administrators regarding the review meeting, Seamans stated that one of the fundamental points that needed to be stressed in AAP was the development of "a clear and defensible rationale for the missions." He further noted he had reported to Webb that the meeting had shown that experiments development was the pacing item for the program, that "only two small AAP experiments have actually been committed to development," and that options such as reuse of Gemini and Apollo experiments and identification of experiments for "rapid in-house development" were being considered.

After another year of development, it was reported in a March 1967 review meeting that 52 AAP experiments had been brought to the development stage. However, management difficulties in the process still occupied a central place of attention. Evaluations at program reviews cited the basic problem as "a need for a clear objective for the manned space flight experiments program," since "the program was approved without real understanding of what we were buying." Communications problems also were cited in regard to NASA centers participation: requests and responses were cited as too slow and informality in making changes and in communications as preventing adequate coordination.

Such problems persisted through the period covered by this study. As late as summer 1968, OMSF personnel were reporting lack of firm experiment programming as a serious difficulty in the Apollo Applications program. The solar telescope experiments were the only ones enjoying a solid place in the program, in that physical work on the LEM/ATM craft had progressed sufficiently to give it a fixed configuration and role in the AAP missions. However, as will be seen in Chapter VI, even the ATM came up for review at top levels on the explicit premise that the agency was going to drop it from the program.

LMSS and the 1-A Mission

Description of the internal and technical aspects of the development of the AAP would not be complete without note of two decisions taken by OMSF that related to the status and stakes of OSSA within the NASA organization. These were the Lunar Mapping and Survey System (LMSS) cancellation and the cancellation of the "1-A Earth Resources Survey" mission.

One of the most important and basic problems of the Apollo program was selection and verification of a proper landing site for the LEM, or in agency jargon, the problem of "site certification." This was a touchy problem since the LEM is designed specifically in terms of definite landing parameters, and a landing on an area with characteristics outside of these basic design assumptions easily could result in a disastrous overturn of the craft with consequent stranding of the crew on the lunar surface.

OSSA undertook three programs for carrying out the site certification task. The first of these was Ranger, a probe that was designed to "hard land" or crash into the lunar surface after transmitting pictures of selected lunar sites on its collision course flight. A second such OSSA program was Surveyor, which was a soft-landing craft to gather both picture data and information about characteristics of the lunar soil. The most critical of the three, however, was Lunar Orbiter (LO), a spacecraft placed into low orbit around the moon so as to take sharp close-up photographs of extensive areas, and to gather data on the moon's size, shape, gravitational field, and other relevant aspects of the lunar environment.

Mueller in OMSF did not feel enough confidence in the LO program to rely on it for Apollo site certification. To his view it represented a "stretching" of the state of the art that could fail, be cancelled, or perhaps yield inadequate data. As a "backup measure" in his view, he decided to fly a secret Air Force camera mapping system (the LMSS) with the Apollo CM on manned lunar orbital flights that would precede the actual landing and accomplish the site certification task. The LMSS, because it would have recoverable film, would offer more and better data than LO.

OSSA "could never understand" why Mueller did not trust the LO program and pushed ahead with LMSS. There was a clear feeling among people working closely with Mueller that he was "thinking about post-Apollo applications of LMSS," since lunar science was not highly developed and the sophisticated data LMSS could gather seemed scientifically useful. However, no one could tell which factor weighed more heavily in Mueller's mind, site certification or post-Apollo use.

Orbiter I was launched on August 10, 1966; soon, together with Surveyor, it produced spectacular photographic views of the lunar terrain that clearly surpassed the Russian "Lunik" photos released in 1965. Subsequently, the Houston Center told Mueller that, with Lunar Orbiter sufficient data had been obtained to certify confidently sites for the Apollo landing. Meanwhile, although utilization of the already developed Air Force camera system had seemed an inexpensive method for developing LMSS, costs on the project had soared and a budget squeeze had set in.

Hence, in mid-1967 the LMSS project was cancelled, although the first system was 90 percent complete at the time of termination, and a second system was 60 percent complete.

As the Apollo Applications program unfolded, the emerging political realities dictated that "man-in-the-street" payoff must be one of the main themes in selling the program to Congress. This emphasis intensified interest in the development of earth resources survey missions, wherein water, mineral deposits, plant disease (on wheat, forests, etc.) were located by remote sensing devices in earth orbiting spacecraft. While there was a great deal of interest within the agency, especially within OSSA, in this type of mission, the agency had done virtually none of this type of work except as a side-product of meteorological satellite operations. (In addition, some of the photographs taken during the Gemini program demonstrated the effectiveness of this type of data gathering from spacecraft.)

One of the technical problems faced in this regard was the fact that resources survey was not feasible through the usual automated satellite technique employed for research in OSSA projects. Remote sensing devices were then at a state of development where they only could be employed effectively at rather low altitudes. If flown in an automated satellite at such altitudes, however, the orbital decay rate would be such that the craft would be drawn into the earth's atmosphere and destroyed so quickly as to make the flight impractical. Manned missions, on the other hand, offered a number of technical advantages. Manned craft normally flew in low altitude orbit, and manned craft allowed return of cameras and film, greater payload complexity and weight, and more power. Also, man could play an important developmental role, in that a crew member could make adjustments, change types of film rapidly, and perform other experimental tasks that could point the way for optimal development of automated craft. Man could "do research" in other words, that would be virtually impossible to carry out effectively on automated craft.

As will be seen in Chapter VI, during the critical FY 1968 budget considerations in Congress, the AAP did not fare well and was cut substantially. In the period between budget consideration and issuance of the agency's 1968 Operating Plan in November 1967, an earth resources survey mission was studied and incorporated into the program. Because the stringent budget situation apparently was going to delay the AAP launch schedule, it was determined that an interim "training mission"--designated "AAP-1A" to indicate its preliminary nature--would be valuable in providing launch and flight experience on heavily experiment-oriented missions. The Martin Marietta Company was issued a contract to study such a mission; after 60 days of work, its research team reported, on September 20, 1967. By November 12, a

Mission 1-A Project Plan had been developed at the Houston Center

The hardware configuration decided upon was, simply, the Apollo CSM with minimum modifications and a special experiment carrier which consisted of a welded aluminum truncated cone carried in the SLA area. In flight, the CSM would transpose and dock with the experiment module and fly in a nose-down, crew-forward position to allow sensor devices in the cone to be aimed earthward, and to minimize disturbing torque, contamination, orbital decay, and other undesired factors. Crew members could move back and forth from the CM to the cone to change film and perform other tasks, as shown in the following illustration of the flight hardware. The CSM capabilities were extended by use of independent subsystems designed specifically to supplement the craft for this mission.

A great deal of enthusiasm for the mission developed in OSSA, and experiment work was carried forward rapidly. A wide variety of sensing devices, such as a metric camera, which would provide unique and invaluable "control data" for earth mapping projects, were planned for inclusion in the mission. Through multiband photography, valuable geological data would be gathered and hydrological examinations made that would provide data for such water problems as flood, drought, and pollution control. Such directly human-payoff related data as those for an inventory of world agricultural-forestry resources, plant disease and insect infestation would be gathered. Similarly valuable and "payoff" related purposes would be pursued in oceanographic, geographic, and meteorologic sensing experiments.

While enthusiasm for the 1-A mission mounted in OSSA, it soon diminished substantially in OMSF, and the mission was cancelled. One result of this decision was the creation of a good deal of ill-feeling in the OSSA organization, a feeling centered on the idea that space science had been "sold out" to the manned capability objective. The argument that OMSF used in rationalizing its decision to OSSA was simply that money was tight and the mission was technically and politically infeasible. The technical point regarded the inclination (in terms of degrees of plane up from the equator) of the orbit specified for the mission. The Martin-Marietta study had specified an orbital inclination of from 45 to 50 degrees. There basically were two reasons for this requirement. One was the fact that resources sensing could be carried out best in daylight with overflight of as much of the continental United States as possible, particularly so that established U.S. Department of Agriculture test areas could be covered. Secondly, with high inclination orbits, greater air mass contrasts could be obtained in meteorological sensing. OMSF engineers argued that the inclination requirement was infeasible since the usual Kennedy launch orbital inclination was only about 33 degrees off the equator. OSSA simply denied this objection on technical grounds, and argued that the inclination was feasible.

A second area of concern raised by OMSF regarded the international-political aspect of the mission. Its argument was that sensing of this sort on a worldwide basis would create international repercussions from the other nations involved, and perhaps would require to be negotiated treaties allowing such overflight. OSSA's counterargument was that OMSF was "imagining difficulties." OSSA pointed out that meteorological satellites already were making worldwide sensing missions, that OSSA had plans for an unmanned 1-A-type mission at a later date, and that, if the presence of men in the spacecraft was the problem, then the same type of objection should stop the Air Force MOL program, which clearly would involve earth-looking experiments. OMSF priorities dictated that the mission be cancelled, however, and it remained cancelled.

Criticism and Skepticism

PSAC's Technical Critique[7/]

As NASA was giving hard shape to the AAP and other future space programs, a review of its efforts was undertaken by the Space Science Panel of the President's Science Advisory Committee. Of particular interest in the report on this study, which was issued in February 1967, were the strong technical criticisms made of the post-Apollo programs. The report implied that most of these problems resulted from organizational difficulties in the agency, particularly from the severe separation of science and manned flight operations. PSAC's terms were: "NASA organization is potentially awkward and illogical for the planning of major new space programs."

To the Committee's view, this fact was made evident in several places, one of the most serious of which was planning for planetary exploration. Two proposals for such exploration were presented separately for the Committee's review. One was the "unmanned Voyager" and the other the "Manned Voyager" flyby. PSAC was struck that these two programs were "distinct and apparently independent plans" and indicated an "absence of integrated NASA planning in this area." It was particularly critical of the overly ambitious nature of the "Manned Voyager" concept and of the fact that the plan showed no unique role for man.

7/ President's Science Advisory Committee, The Space Program in the Post-Apollo Period. A Report, February 1967.

A similar type of criticism was voiced in regard to the ATM experiments for AAP. The report noted that a "large orbiting telescopes program [which envisages] an eventual decisive role for manned engineering operations . . . requires a degree of intimacy of manned space operations and scientific engineering operations which has not been reached heretofore and for which the administrative structure of NASA is not optimized." The necessity of this requirement was reflected in the detailed technical criticisms leveled at the LEM/ATM concept, which the Committee took as NASA's decision on how to fly the telescope. In sum, the PSAC panel evaluating the LEM/ATM configuration concluded, "It is clear to the Panel that from a conceptual point of view this is the wrong way to carry out a man-supported astronomy project in earth orbit . . . ." This conclusion was based primarily on the inutility of placing a man in the LEM to operate the telescope. The panel noted that in terms of control, the man could be 10 or 100 feet away from the telescope platform and operate it more effectively than when he was in it, since his movements had to be taken into account in stabilizing the instruments for the extremely fine pointing accuracies required (the quick movement of just a hand to reorient toward a developing solar flare could upset the pointing). The demands on the man, the report further noted, were to do things that ideally should be done on the ground, and capability for the one valuable function that man clearly could contribute to the telescope's operation--repair and maintenance--could not be developed in the LEM/ATM configuration because of its tight time schedule. The panel also expressed pessimism that astronauts could live up to the performance expectations required of them in operating the telescope. Overall, the panel concluded that ATM was scientifically valuable, but that the schedule should be slipped one year so that an operation mode removing the man from the telescope could be developed.

Similar types of technical criticism were directed at the S-IVB wet workshop concept. Evaluation of the biomedical aspects of extravehicular activity (EVA) in the Gemini program indicated to the panel that serious doubt existed whether astronauts in space suits could carry out the tasks required for outfitting the S-IVB tank as a habitable laboratory: at this point plans were not to build any facilities into the tank before launch. Work in space has been shown to be difficult and the rapid breathing and heart action that occur in EVA are not understood fully. Body orientation and stabilization and severe fatigue problems indicated, to PSAC's view, that the "developmental" or "constructed" space station concept on which S-IVB workshop plans were based involved a too ambitious prediction as to what astronauts could do in space and glossed over some basic biomedical questions. PSAC thus recommended that a prepared space station, based on the Air Force MOL, was the better concept for the interim period while biomedical factors were being investigated. In sum, the two most important hardware innovations of the Apollo Applications program, LEM/ATM and the S-IVB workshop, were brought under harsh technical criticism at the time the agency's attempts to fund the program were reaching a climax.

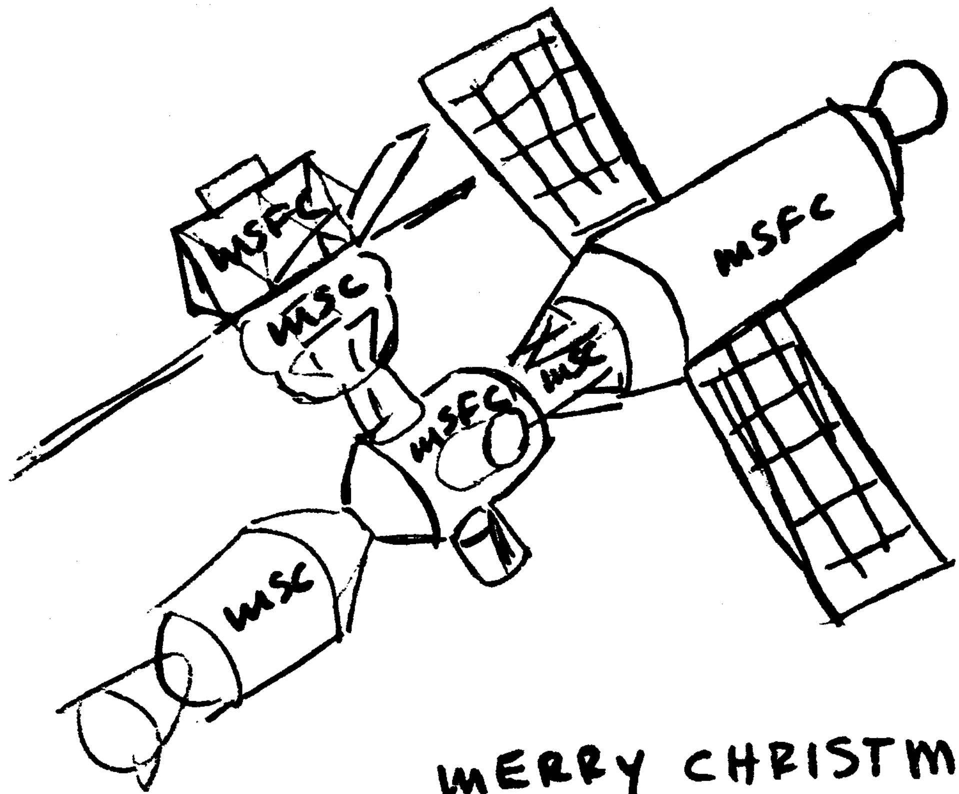
Internal Organizational Reaction to Technical Aspects of AAP

As the technical decisions described above were taken and the AAP hardware configuration took shape, attitudes within the agency toward the program formed in rather sharp outline. Mueller and Von Braun with the Marshall Center formed the core of its advocates, while the Houston Center became the locus of some opposition to the program and much disdain on technical grounds.

This was illustrated by the organizational humor that developed at the Houston Center. A cartoon circulated among Houston engineers depicted two men connecting an intercontinental railway, with only one track joining and the other two ends off center to the left and right. The two men were scratching their heads in puzzlement, and the caption simply noted "AAP." Another cartoon showed two Martians in a spacecraft observing the total AAP configuration in flight. One, looking puzzled, was being told by the other, "I don't know what the hell it is, but I think they call it an 'AAP.'" Jokes circulated that described "AAP" as short for "Almost A Program," and the "Apples, Apricots, and Pears" program. The perception that Houston and Huntsville had conflicting stakes in AAP and that MSFC had come out the better in the conflict was indicated in the following cartoon, circulated in the NASA Washington offices.

At the headquarters level, morale suffered as options were changed and the plaguing problems of payload development continued with little abatement. Costs for hardware development escalated in quantum level jumps and a serious problem of program control appeared to be developing on the technical side. An overview of cost histories on the various hardware components of the AAP configuration indicated the extent of this problem: As costs grew, a harsh attitude developed at the top level toward the technical conceptualization of AAP. Highest management officials were heard to make such remarks as "AAP must have been drawn up at lunch on the back of an envelope."

Feelings developed that the political environment was increasingly threatening and the agency's public and congressional image was damaged severely by the Apollo 204 fire in January 1967. The fire produced an additional technical perturbation that further upset some spacecraft engineers at the Houston Center: namely, the decision that North American Aviation, builder of the CM who were brought under much criticism as a result of the fire, would not be allowed



MERRY CHRISTMAS

to contract for the CM modifications that would be required for its use in AAP. This meant that the CM's would have to be transported to another manufacturer for modification. The stresses imposed by transportation, plus the problems involved in having a manufacturer unfamiliar with the spacecraft modify it, seemed technically impractical to the Houston engineers. In the midst of these external conditions, a concern developed that top level decision-making in the agency was not firm enough to allow adequate technical decision-making. This attitude also showed up in cartoons drawn and circulated by agency personnel. (One showed a man's head drawn in four separate parts and was captioned "Headquarters.") A hearty round of laughter was heard in an AAP program review meeting when the presenter flashed a proposed "working definition" of "Top Management Action" on the Vu-Graph screen:

Top Management Action is reported to be equivalent to the

Mating of Elephants

It is all performed at a very high level.

It creates a lot of dust.

It takes 21 months to produce the results.

Such was the internal-technical context that developed as the post-Apollo program came into the purview of the larger political system.

CHAPTER V

POLITICAL CONSIDERATION OF MANNED SPACE ISSUES: THE PRELIMINARY PHASE

NASA's bureaucrats and their associates--whether engineers, scientists, administrators, or contractors--are immersed in a complex political system from which they draw their sustenance and direction. Their activities merge upward, with the agency, Congress, and the President above them. The consideration of manned space issues by these three, exercising controls "on behalf of the public," is the subject of this and the following chapters.

The President Calls for Future Plans

President Kennedy urgently pressed for early achievement of the lunar landing. He sometimes referred to the possibility of a 1967 landing, and even once, Seamans reported to the authors, inquired about the possibility for 1966. By 1962 NASA was beginning to think of extended objectives, and in that year proposed to the President a $6.2 billion budget for FY 1964 to carry forward a program beyond the lunar landing. The President questioned the assumptions behind a budget request of this size. (It supported a balanced program of aeronautical and space development, as well as the manned lunar landing that the President regarded as the principal objective.) Seamans told the authors that he recalls that the President, sitting across the table from Webb, said he wasn't sure he agreed with the statement Webb had made that the budget should support "total capability." Webb, on the other hand, remarked that he would not take responsibility for a program that was not a balanced one. The President asked for clarification, and Dryden, Seamans, and Webb prepared a 9-page letter of explanation. The purpose of the letter, dispatched November 30, 1962, was to emphasize the need for preeminence in all aspects of space endeavor.

On April 9, 1963 the President sent a letter to Vice-President Johnson in which he expressed the need for a clearer understanding of factual and policy issues relating to the space program. He asked for a report on its benefits to the economy, its impact on major national problems, and the extent to which it could be reduced, beginning in FY 1964, in areas not directly affecting the Apollo program. A copy of the letter was sent to Webb with the request that he assist in preparing the material.

Supplementing this probe for information were White House discussions on current issues of space policy. There was a difference of opinion in the White House on engineering development and testing of the nuclear rocket engine program (Rover, including the NERVA engine). The principal people in rocket planning were involved: Webb; Robert S. McNamara, Secretary of Defense; Harold Brown, DOD's Director of Defense Research and Engineering; Jerome Wiesner of PSAC; and Glenn T. Seaborg, Chairman of the Atomic Energy Commission. Webb and Seaborg wanted the increased capability of the NERVA engine, but Brown objected. He reflected McNamara's and Wiesner's view that there was no point in developing an engine if there were no missions projected for it. Webb and Seaborg obtained approval to continue the development work on NERVA, although they did not obtain approval for flight testing a nuclear vehicle (for what was called RIFT, i.e., Reactor in Flight Test). Thereafter Wiesner prepared a draft of a letter asking that the missions be defined for the President to send to Webb. Several people, including NASA staff members, helped rewrite the letter in a broader framework. Upon Kennedy's assassination Johnson inherited the letter, and transmitted its final draft to Webb on January 30, 1964. The letter--precipitated by an immediate conflict--led to a NASA study of post-Apollo objectives and a public presentation of the alternatives that might be chosen.

The President, "reflecting on our recent decision as to the 1965 budget level of the Rover program," expressed concern "that we be in a better position to make future decisions involving this and other large space programs." He noted that the argument against NERVA was "the difficulty in defining missions" for it that could not be performed by other systems already more advanced. He stated the objective of "relating hardware and development programs to prospective missions." Accordingly, he requested a review to include at least three things: (1) "A statement of possible space objectives beyond those already approved." The views of the scientific community, particularly of the Space Science Board of the National Academy of Sciences on "aims and missions for scientific purposes" should be obtained. (2) A review of "the planned research and development programs" of NASA "in relation to these aims." (3) Review of R&D programs under way, both by NASA and DOD, in the light of (1) and (2). Special emphasis was placed on considering "alternate booster arrangements" and whether "our needs of the next decade can be met by boosters already under development." That the President expected a searching analysis was indicated by his request for a progress report about May 1 and a final report not later than September 1, 1964.

To make this study Webb created a Future Program Task Group under the direction of Francis B. Smith, engineer-administrator at Langley Research Center, who was assigned for this purpose to headquarters with the title of Special Assistant to the Administrator. The total resources of the agency were marshalled through subgroups, memoranda, and agency discussions. Of particular interest are the views submitted in several memoranda. Mueller, with an emphasis distinct from that of the President on missions, laid this predicate for his statement: "It is imperative that our space objectives be capability oriented as well as mission oriented." Common elements in a broad technological base could support any and all missions and could allow for accommodation of mission changes. He noted that among the goals chosen were a manned space station for synchronous earth orbit and establishment of a lunar base, and that the goal for planetary exploration should be a manned landing on Mars. He set forth three plans, each emphasizing earth, lunar, or planetary exploration, and a fourth embodying all of these extensively. He showed costs over a span of time for each; the first two plans were possible with the current level of expenditures for manned space--above $3 billion per year, the third emphasized planetary research going to $4 billion per year, and the fourth required 5 percent increases in costs per year. He regarded the assumption of current levels of expenditure as "a most conservative approach in view of an increasing GNP and the desirability of the NASA furnishing the stimulus required to improve the nation's technology at a greater rate." He presented charts showing upward trends in funding for future programs as Apollo expenditures declined.1/

Mueller's statement of technologically-oriented development, sustained by a constant or increasing level of funding, as a base for optional manned missions was a profile of his more extensive presentations to congressional committees in the following years. While this statement from the head of OMSF conforms with the expectation that the person responsible for a function will present to his superiors advanced plans for expansion and use of the function, no such expectancy would exist for Homer Newell, Associate Administrator for OSSA. Yet Newell went further than Mueller by specifying a manned flight goal for the future.2/ He believed that NASA needed "a clearly defined goal" beyond Apollo that could "capture and hold the imagination and support of Congress and the nation." Naming four possibilities--extensive lunar exploration, a manned space station, capability for complete freedom of man in cislunar space, and manned exploration of the planets--he concluded:

> Of these, there is one especially suited to capture the public imagination and support, that is, the manned exploration of the planets. I firmly believe that man himself will ultimately have to explore the planets to satisfy his fundamental drive to extend his knowledge and control of his environment. Therefore, I believe that we should recommend to the President that this be the next major goal of the NASA. If this is done then the other goals I have listed will become logical milestones along the way.

1/ Memorandum of April 28, 1964.

2/ Memorandum of April 29, 1964.

Other goals listed included, among others, an expanded unmanned exploration of Mars in 1969, and a broad, coordinated program of solar-terrestrial-interplanetary studies during the next solar maximum (1967-1972).

Quite different were the recommendations submitted by the Space Science Board.[3] Although it approved biomedical research and development to be ready for use by man in space flight by 1985, it rejected manned space flight as the new goal for space effort. It thought a fixed goal was desirable and that this should be planetary exploration, primarily carried out by unmanned vehicles until solution of biomedical and bioengineering problems in manned space flight. Lunar exploration and a manned orbiting station should be rejected as primary goals. It recommended development of a large rocket vehicle and spacecraft, capable of serving the whole planetary exploration, over a period of 15 years so that it could be produced with mass-production economies.

In view of the President's interest in booster needs, this received special attention from Smith's task group. One report to it from Milton W. Rosen, a rocket specialist, surveyed needs and possibilities and saw a "definite need" for addition of a high energy stage to either the Saturn IB or the Titan 3 (either by the existing Centaur or other method) to support the Voyager (unmanned exploration of Mars and Venus) and other missions. For the needs between 1975 and 1985--assuming manned planetary exploration, unmanned probes out of the ecliptic and close to the sun, and a large orbital space station--new launch vehicles with chemical, nuclear, and nuclear-electric propulsion were anticipated.

Seamans, a high-level associate has said, had declared that he would "be damned" if they would put forward a program that did not make use of what NASA already had. Webb transmitted to the President a preliminary report in a letter of May 20, 1964; in it he reviewed first and at length the capability already developed by NASA and stated that the "overriding objectives" should be "to foster, to preserve, to improve, and to make more effective" this basic system.[4] Thus, an incremental approach for the task force was foretold.

3/ These recommendations are listed as "National Goals in Space, 1971-1985," on pp. 478-84 of U.S. Senate, Committee on Aeronautical and Space Sciences, National Space Goals for the Post-Apollo Period, Hearings on S. 927, 89th Cong., 1st Sess., Part I.

4/ Both the letter and the Summary Report, Future Programs Task Group may be found in U.S. Senate, Committee on Aeronautical and Space Sciences, Hearings, NASA Authorization for Fiscal Year 1966, 89th Cong., 1st Sess., Part III, pp. 1027-102. Cited hereafter as Senate Space Committee, FY 1966 NASA Hearings.

The report of the Task Group was completed in January 1965 and transmitted to the President with a "Foreword" by Webb. This Foreword revealed both the capability orientation and the incremental planning of the Task Group. Webb reported that it had studied "(1) the capability being created . . .; (2) next step or intermediary space missions that could use or extend this capability; and (3) a number of long-range missions which deserve serious attention." This distinction between intermediary and long-range missions had not been mentioned in the President's letter. The former, strongly emphasized in the Report, provided an opportunity to base program plans on existing capability.

The report referred to the "versatile family of launch vehicles and spacecraft, and the trained manpower and facilities" developed over six years; it concluded that "other things being equal, these capabilities, with the resultant gain in reliability, should be used to the maximum degree in future missions." The intermediary program suggested as possible on the basis of technological advances combined the objectives of the Space Science Board and the manned space advocates in NASA. For unmanned planetary exploration, desired by the scientists, the Voyager program was included. Using the Centaur as a third stage on the Saturn IB, a ten-thousand-pound Voyager spacecraft, equipped for surface and atmospheric measurements, could be soft-landed on Mars in 1971. For manned exploration the Apollo program, by 1969, could build up capability for launching annually six Saturn IB's and six Saturn V's with eight Apollo spacecraft. The Apollo-LEM system, with modifications in the service and LEM modules, had "a large and versatile capacity for a variety of missions." These "Apollo Extensions" could include both earth orbital and lunar exploration, the former with two or three men on one-to-three-month missions, and the latter with three men mapping the moon on a twenty-eight-day mission or two men engaging in surface exploration for from one to two weeks.

The report set forth very briefly and sketchily the experiments that could be conducted on these missions and the potential payoffs. Biological experiments on the effects of the space environment on man's physiological processes and on the effects of zero gravity and radiation upon the growth rate and mutation rate of bacteria, and more extended experiments on a primate, would be possible. Meteorological experiments could be conducted. The feasibility of synoptic and multisensor mapping of earth resources could be determined. Astronomical experiments could be conducted in which man could repair, replace, and modify instrument packages in flight. Lunar exploration could supply new knowledge on the origin of the moon and the origin and early history of the earth. Basic questions of scientific interest on the behavior of liquids, solids, and gases under zero-gravity conditions could be answered by simple tests.

A final section of the report reviewed the advanced developments necessary to "provide the foundation for the space program of the more distant future." In the period beyond 1975 unmanned planetary exploration, which would make use initially of Voyager spacecraft and the capability of the Saturn IB-Centaur or Saturn V, could be extended. Building on the longer duration Apollo missions, a manned orbiting laboratory to accommodate six to nine men, with crew rotation and resupply by rendezvous for possibly five years, might be developed. A large telescope might be placed in orbit in conjunction with this laboratory. Possibilities in manned lunar exploration included exploration beyond plus-or-minus ten degrees of the lunar equator and a lunar "jeep" for extended tours of the moon's surface; much further in the future was projected a semipermanent or permanent lunar base, and finally construction of large radio astronomy antenna on the moon's surface. Set forth as "possibly the most challenging long-term goal of the entire space program" was manned exploration of the planets, especially of Mars. "One of the most significant events in the history of mankind may well occur when man first sets foot on the planet Mars, possibly to view plant and animal life unlike anything ever seen on Earth."

For these future manned explorations the existing launch vehicles in most cases would be sufficient, but for manned lunar exploration beyond the equatorial region and manned planetary exploration more powerful launch vehicles would be required. The report noted the investigation of an M-1 chemical thrust engine and large solid propellant motors (the 260-inch solid). Particular attention was given to the NASA and AEC joint program for nuclear rocket propulsion (centering on the NERVA). A nuclear third stage on the Saturn V was a possibility. For spacecraft development in the future the major need was for advances in spacecraft electric power propulsion.

Webb accompanied the transmission of the report to the President with a letter dated February 16, 1965.[5] He wrote that "two objectives for the years just ahead appear to stand out above other possibilities. Both appear to be within the framework of feasible resource levels for fiscal year 1967 and following years." He referred to the unmanned soft-landing on Mars in 1971 and "a systematic program extending over several years to capitalize on the availability of the Apollo-LEM manned space flight system for a wide variety of worthwhile scientific and technical missions in near-Earth and synchronous orbits, in lunar orbit, and on the lunar surface." These were the Voyager and Apollo Extension programs, one for unmanned, the other for manned space exploration.

The final paragraph of Webb's letter began with a sentence that revealed his view of the kind of political support needed for sustenance of a large space program: "More than in most areas, major decisions on space require a broad consensus." He thought that selection of new space

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5/ *Ibid.*, pp. 1027-29.

missions would be the subject of study and debate by many individuals and agencies in public and private life; in other words, the selection would be a political one and could not rest on NASA's recommendation alone. He, therefore, suggested the possible desirability of making the report public. This was done. Webb himself sent copies to many individuals, and the report was printed in Senate Hearings.

The Smith Report was only a statement of possibilities, a moment of deliberation, not a commitment of the agency to any program. It was tentative and, hence, did not generate the thoroughness of review and agony of decision characteristic of agencies' commitments. At the time NASA's attention was focused on the Apollo mission; there was episodic planning for the future and little work by planning personnel attached to the Administrator's office on long-range future plans; the agency was not ready for firm recommendations. A former official of the Budget Bureau has said that the report was not given much attention in the Bureau at the time, for there, too, attention was on requirements for the Apollo program.6/

Nevertheless, the President's request, the report, and Webb's statements provide in important ways an introduction to the deliberations on post-Apollo manned space policy at top levels in NASA and in the Executive Office and Congress. First, the report contained a profile of issues to be debated in the following years. Second, it and Webb's letters revealed the concentration of attention in NASA on intermediary missions making use of existing hardware capabilities and deferring consideration of long-range goals until more experience was gained and congressional and public support of new, expensive, long-range developments could be anticipated. Third, specifically included was Apollo Extensions, a manned space flight program. Fourth, the report stated immediate planning objectives in terms of continuation of existing budget levels and use of six Saturn IB's, six Saturn V's, and eight spacecraft for manned space flight per year. Fifth, the manned missions for which this equipment would be used were described indefinitely and the experiments and payoffs were presented sketchily and tentatively. Finally, Webb closed by suggesting the need for national debate and for "a broad consensus."

The latter three features of this milestone in the consideration of space objectives point to central aspects of the search for policy in the succeeding years. In Webb's thinking Apollo Extensions and Voyager, like the Apollo mission itself, were not important in themselves. What was important was the ability to fly six Saturn V's and six Saturn IB's per year to maintain a capacity beyond that of the Russians. He saw a

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6/ Interview with Willis H. Shapley, May 28, 1970.

comparison with the airplane, which was developed without knowledge of what services it would be capable of supplying. He wanted to develop and retain a capacity sufficient to keep the Russians from feeling overconfident about their relative technical potency. Such overconfidence, he feared, might lead the USSR to take risky actions that might strain US-USSR relations, even to the point of threatening war.7/ Also, within OMSF and among its contractors, the 6-6-8 formula for boosters and spacecraft was viewed as a means of keeping a production team intact and avoiding a curtailment of the level of space effort.

Yet the question of missions--of the use of the capability--which had led to the President's letter, could never be removed from policy discussion. Congress would be interested in payoffs and impatient with indefiniteness in mission planning. NASA officials--conscious of this attitude within Congress, the science community, and the public--would be under pressure to produce from the many suggestions on Apollo Extensions a more definite program. Seamans, in particular, persistently would press Mueller to present definite plans with respect to earth and lunar missions and the various NASA divisions to define experiments to be carried on these missions.

Finally, there would be an effort by Webb to push the issues on space policy into the arena of macropolitical discussion. The Task Force report was sent in the first week of April 1965 to Senator Anderson and Congressman Miller, upon request of Jack Valenti, a presidential aide, with a letter from Webb that had been presented to Valenti in advance. Webb stressed that the report was only a statement of capabilities and that it did not represent a projection of what NASA would propose or what the President would approve in FY 1967 presentations. Conscious as an experienced government official of the futility of agency leadership moving forward with an aggressive program without presidential and congressional support, Webb sought debate and consensus from those sources. Some observers thought he was overreluctant to press his own view on a future program and overconsiderate, as an ex-chief of the Bureau of the Budget, of the rival requirements for government expenditures. An observer of top executive deliberations said that he observed the President ask, "Do you need this," and Webb reply with an affirmative coupled with, "But, Mr. President, you must be the judge of the priorities among competing claims."8/ All commentators seem to agree with respect to one thing: Webb respected the President's position on budget levels and priorities, and never made any effort to circumvent the presidential position with his own recommendations to Congress.

7/ Interview with James E. Webb, February 19, 1969.

8/ Interview with Robert C. Seamans.

There was a major difficulty on the debate and search for consensus that Webb desired. He thought in terms of national capability and of national preeminence in space. What concerned him was the size of the budget and the flexibility in its use that would make possible the development of the national capability. But the President and science's representative, Wiesner, had shown an interest in missions, and Congress also would be interested in what these would be--in the payoffs from the capabilities. Although Webb could take comfort from the idea that at least seven or eight of the most influential members of Congress on space issues knew his view of the issues in the debate, there would be a demand, even among some of these leaders, for a debate on another plane--that of mission details. And at least one prominent member of Congress would contend vigorously and persistently that it was neither an issue of amount of money, nor of missions, but of whether the agency would use its money to move to new levels of capability.

The report to the President stated policy potentials as seen within the administering agency. Webb was interested in capability, specifically in maintaining the capability for Saturn flights; his agency framed for him the missions to be flown on these flights. Apollo Extensions, making use of and expanding Saturn-Apollo capability, was pushed from the manned space family to the forefront in agency, presidential, and congressional consideration. Voyager represented interests within the unmanned sector of NASA, but it too was a matching mission for Saturn boosters and thus engaged the support of that part of the manned space family that was producing boosters. There was inherent in these programs, and explicit in their explanations, a particular policy objective: conservation and incremental expansion of existing technology. The objective fitted the interests of the most powerful segment of NASA itself, that of Webb in continuing Saturn V production; it postponed also the hard issues on a long-range program, for which there was neither technological nor political readiness. The policy potentials, and the objective, were to form the basis of budget decisions in the macropolitical system.

The Budget for FY 1966

The NASA Task Force report was being completed in the same time period as the final preparation of the President's FY 1966 budget, and discussions of that budget in Congress would provide the first occasion for an open discussion of Apollo Extensions. The first of several influences that would affect the political strength of NASA's pleas for a post-Apollo space budget was now visible. Following his decisive victory at the polls, President Johnson made a strong statement to the Cabinet on November 19, 1964. This statement, released immediately to the public, asked for economies in old programs, "using the savings for the new programs of The Great Society." Four days later the Director of BOB asked each agency for a statement "of desirable reforms in ongoing programs" that would help "to free funds" in FY 1966 and later years for urgent programs. The President's budget, submitted the following January, proposed an increase in expenditures for health, education, economic opportunity, and other welfare programs from $7.4 billion in FY 1965 to $11.8 billion in FY 1966.

The day following the President's announcement to the Cabinet, Edward Welsh of the President's Aeronautics and Space Council wrote to Webb and stated that "it is hoped that the space program . . . would be considered 'urgent requirements' essential to the concept of the Great Society." Noting that NASA had cut its request for FY 1966 to $5.5 billion by refraining from new adventures, he suggested that Webb make clear in his reply to the Bureau that the $5.5 billion was essential for his program. Webb did this in his reply of November 30. He stated that NASA had no "outmoded programs" and that the space program would provide an "inspirational thrust" toward the Great Society. He referred to economies made in the FY 1963 budget by cancellation of manned flights on Saturn I missions and adoption of the all-up testing procedure that he had told Congress, even before a $195 million cut by it, left only "a fighting chance for the lunar landing in the decade."

At the time the President made his FY 1966 recommendations, the Great Society program did not have a serious effect on space expenditures. NASA in general was not ready for new adventures, except in the study stage, and the enormous construction of facilities for existing programs at centers and contractor sites was nearing completion. The President's budget recommendation of $3.260 billion included a $200 million increase for R&D, which was always the largest part of NASA's budget. Senator Smith, Congressman Heckler, and the Senate staff were disturbed that budget constraints cut off work on the M-1, SNAP-8, and 260-inch solid motor (more than $160 million already had been spent on the first and over $100 million obligated on the third).9/ But funds were included for expansion at the design stage for the Voyager and at the study stage for Apollo Extensions, neither of which, however, were as yet sizable enough to be included as line items in the budget. Included also was initiation of an Advanced Solar Orbiting Observatory. The new programs apparently justified continuation of Saturn launch vehicle production, for both Voyager and Apollo Extensions would use these vehicles.

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Senate Space Committee, FY 1966 NASA Hearings, Part I, pp. 10-12, 45-47; U. S. House, Committee on Science and Astronautics, Hearings, 1966 NASA Authorization, 89th Cong., 1st Sess., Part I, p. 13 (hereafter cited as House Space Committee, FY 1966 NASA Hearings); Office of Legislative Affairs, Files, Memorandum from C. E. Cresin, February 24, 1965. The latter notes the concern of the Senate Space Committee staff about the number of nuclear programs started and stopped.

For Apollo Extensions, which was the name for the emerging new manned space program, the relatively small sum of $14 million had been set aside by NASA initially in FY 1965 agency allocations. Of this, $11,100,000 was allocated before the end of the year and an additional $10,370,000 of Advanced Mission study funds.10/ For FY 1966 an expenditure for Apollo Extensions specifically of $48 million out of R&D funds was proposed by NASA and an additional $10 million for advanced studies on manned space flight.

The budget for FY 1966 was presented to the authorization committees before the release of the Task Force report to the chairmen of the committees. The budget presentations began on February 17, 1965, in general discussion before the whole Committee on Science and Astronautics of the House of Representatives. Webb told the committee that funds were included for "further use of the Saturn launch vehicles and the Apollo-LEM manned space flight systems in the period following the lunar landing," and said that by 1969 there would be capability for launching six Saturn IB's and six Saturn V's per year.11/ Seamans presented the concept of "a family of potential intermediary missions . . . exploiting present developments."

Mueller elaborated the Apollo Extensions possibilities in testimony before the whole House committee, the House Subcommittee on Manned Space Flight, and the Senate Committee on Aeronautical and Space Sciences.12/ He said that "the basic concept in Apollo extension system studies is to find out how we can best make use of the large investment which the country has in its present manned lunar landing program, and how we can exploit its inherent capability to the fullest extent possible."13/ The point of departure in these presentations is shown here as Figure XIV "Exploitation of Presently Programmed Capabilities."
That plans were tentative was shown by the sketchy presentation of optional earth orbit and lunar missions and the brief references to scientific value of experiments that could be carried on the missions.

10/ U. S. Senate, Committee on Aeronautical and Space Sciences, Hearings, National Space Goals for the Post-Apollo Period, 89th Cong., 1st Sess., 1965, p. 69.

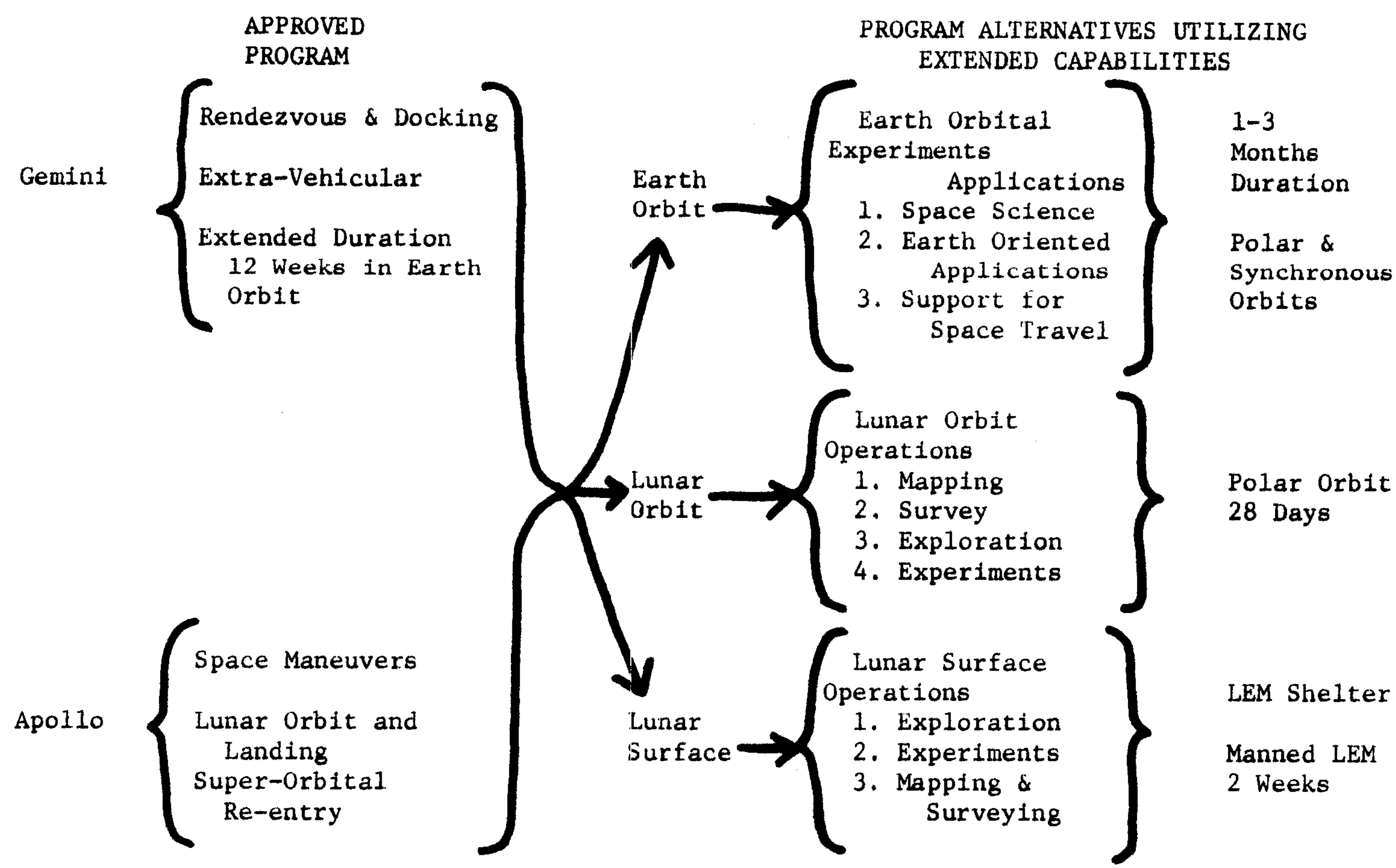
11/ House Space Committee, FY 1966 NASA Hearings, Part I, p. 10.

12/ See House Space Committee, FY 1966 NASA Hearings, Part I, pp. 111-15, Part II, pp. 135-42, 162, 241-43, 252-95, 314; Senate Space Committee, FY 1966 NASA Hearings, Part I, pp. 205-11, 249-358, 264, 274-75, Part II, 844-45, and 856-58.

13/ Senate Space Committee, FY 1966 NASA Hearings, Part II, pp. 857-58.

FIGURE XIV

EXPLOITATION OF PRESENTLY PROGRAMMED CAPABILITIES



Source: U.S. Senate, Committee on Aeronautical and Space Sciences, Hearings, National Space Goals for the Post-Apollo Period, 89th Cong., 1st Sess., 1965, p. 51.

The members of the committees questioned some of these plans. Congressman Daddario was concerned over the danger that the plans as presented "foreclosed the possibility of going into anything else except the adaptation of Apollo-type hardware," and made use of only a small section of industrial competence.14/ Senator Smith wanted information on the differences between DOD's plans for a Manned Orbital Laboratory (MOL) and Apollo Extensions.15/ Senator Anderson wanted to know when it would be necessary to make decisions on post-Apollo goals; Mueller responded that the $48 million requested was for the program definition phase but that the time for decision was imminent. Appearing to misunderstand the scope of Apollo Extensions, Anderson also wanted to avoid commitments to send anybody to "Mars, Jupiter or Venus or Saturn . . . /although/ I am probably quite willing to vote to go to Mars."16/ Senator Holland feared NASA might be "launching a little more ambitiously" into new programs and was concerned over the costs.17/

Space in 1965

The year 1965 was one of achievement and hope for space capabilities. Mariner IV, launched November 28, 1964, flew by Mars and returned pictures of the planet to the earth in July 1965; the Washington Evening Star described this as "one of man's greatest triumphs to date in the field of science and technology."18/ Gemini III, the first manned Gemini, flew 3 orbits in March, Gemini IV 62 orbits in June, Gemini V 120 revolutions in August, and Gemini VII 206 revolutions in December. The Air Force's Titan III-C made its maiden flight on June 18; it was the largest rocket fired to that time and carried the largest payload.

The press in the summer of 1965 exulted over these achievements. The Mars unmanned fly-by and the manned flight successes were reflected in discussion of a manned flight to Mars. Gilruth jokingly said, "We have now qualified one of the subsystems /for manned flight/. That's the crew."19/ The New York Herald Tribune editorialized about "man on Mars by '80?" and said there was now "an onward-and-upward feeling."20/

14/ House Space Committee, FY 1966 NASA Hearings, Part II, pp. 241-42.

15/ Senate Space Committee, FY 1966 NASA Hearings, Part II, p. 274.

16/ Ibid., p. 856

17/ Ibid., p. 857.

18/ Evening Star (Washington, D. C.), July 16, 1965.

19/ Milwaukee Journal, August 30, 1965.

20/ New York Herald Tribune, July 22, 1965.

Von Braun thought the pictures from the unmanned Mariner IV left much to be desired and suggested a three-man team fly-by of Mars. His assistant, Dr. Ernst Stuhlinger, talked about a 465-day manned trip to Mars.21/ Von Braun foresaw men "living on the moon as a matter of course by the end of this century," and the possibility of transforming the environment of Mars to make it amenable to earthlings: man would then "truly be walking among the stars."22/ And William B. Taylor, director of NASA's Apollo Extensions studies, spoke of twenty advanced flights in that program beginning in 1968 and preparing the way by 1980 for lunar bases, multiman space laboratories, and six to eight men on the round-trip fly-by to Mars and Venus.23/

Meanwhile, other voices presented issues with respect to manned space flight. Some observers saw in the Air Force program a challenge to NASA. The Air Force was developing plans for a manned space laboratory launched by an uprated Titan (Titan III-C) and carrying two men in space for 26 days. When the President had asked in January 1964 for a report by NASA on future plans, he had asked for a report on developments under way, "whether sponsored by DOD or your agency," and had referred particularly to launch vehicles. Webb and Seamans were perplexed about how to handle this part of the inquiry. There were exchanges of letters between Webb and Defense Secretary McNamara, many interagency conferences, and collaboration through numerous joint panels, including especially one on launch vehicles. Out of this came a clearer understanding by both NASA and DOD of the other's program, as well as a continued emphasis by NASA on its own Saturn and Centaur vehicles but an understanding that the agency would not oppose the military's manned space program.

Early in June 1965 the House Committee on Government Operations issued a report urging the Administration to give the military a role in space through the MOL and declared that there were "parallel studies, competitive maneuvering, confused pronouncements, and potential overlapping or duplicating plans by NASA and the DOD."24/ Already in May, in views added to the report of the House authorizing committee, four Republican members had lamented "the apparent low priority which has been assigned to the development of a military space capacity," and questioned

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21/ Indianapolis Star, July 18, 1965.

22/ Minneapolis Tribune, May 29, 1965.

23/ The Denver Post, October 11, 1965.

24/ U. S. House, Government Operations in Space, H. Doc. 445, 89th Cong., 1st Sess., p. 17.

whether $1.2 billion for DOD's space program and $5.2 billion for NASA "properly reflects the national security aspects of space exploration." They repeated a recommendation of minority members of previous years for a coordinating congressional committee on space.25/ Congressman John Wydler (Rep., New York) went further: "We have reached a moment in history when a decision must be made between science and security." While he accepted the unmanned planetary program and the lunar exploration goal of Apollo Extensions, he thought that the other goal of Apollo Extensions, manned earth orbital missions, was a military program and should be under military direction.26/ William Hines, a space specialist in the nation's press, was impressed, as was the press generally, by the success of the Titan III-C's launch on June 18. He said that its development cost was cheaper than that for the Saturn IB, and that it might be the "tiger's trap" on NASA's plans to put the Centaur on the Saturn IB for Voyager. He thought NASA had gone beyond its R&D function into an operational role, and that it was time to redefine the functions of NASA and DOD on space.27/

These voices of protest, however, at least for the time being, did not impede the continued parallel development of earth orbiting functions by the two agencies--one emphasizing its general R&D function, the other development of capabilities for the specific military objective. On August 25 the President announced his decision for DOD to go ahead with MOL. The Senate space committee's report in May reflected the prevalent congressional view. After two days of hearings on DOD-NASA coordination, the committee concluded that it would monitor future developments.28/ The consequences of the various deliberations were that the two agencies continued to cooperate and to compete, the military manned space program was assured, and NASA's manned earth orbiting ventures were yet to be defined in specific terms.

The issues concerning NASA's own future program, including the roles of manned and unmanned flight, in the meantime were being discussed in the forums of science. The nation's lunar scientists and associated science groups had a definite view of the value of one part of Apollo Extensions, namely, extended lunar exploration. Meeting in Falmouth,

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25/ U. S. House, Report No. 273, 89th Cong., 1st Sess., May 3, 1965, pp. 137-38.

26/ *Ibid*., pp. 139-40.

27/ *The Evening Star* (Washington D. C.), June 10 and 17, 1965.

28/ U. S. Senate, Report No. 188, 89th Cong., 1st Sess., May 13, 1965, pp. 82-83.

Massachusetts, on July 13-31, 1965, they concluded that, with operational problems being resolved in the first Apollo missions, "plans should be made to gradually increase the duration of stays on the Moon, the distance traveled from the point of landing, and the proportion of the astronauts' time devoted to lunar exploration. A judicious use of 'manned' and 'unmanned' spacecraft will be required to obtain maximum coverage." Manned lunar orbiters initially should provide basic guidance for lunar mapping, and such an orbiter carrying the remote sensing package should be flown prior to the first AES landings.29/

A broader study, undertaken by the Space Science Board of the National Academy of Sciences, was held at Woods Hole, Massachusetts, in June and July of 1965.30/ In the conference report Harry H. Hess, chairman of the Space Science Board, emphasized certain conclusions, including:31/

> We recommend planetary exploration as the most rewarding scientific objective for the 1970-1985 period. In pursuing this goal we recommend a reasonable balance between lunar and planetary programs . . . .
>
> All of our astronomy working groups project a need for large orbiting telescopes and anticipate the availability of man to adjust, maintain, and report these national facilities.
>
> . . . .
>
> The distinction between manned and unmanned programs is an artificial one; scientific objectives should be the determining factors.

The working group on planetary and lunar exploration32/ recommended a shift of emphasis toward the planets and away from the moon in the

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29/ National Aeronautics and Space Administration, NASA 1965 Summer Conference on Lunar Exploration and Science (Washington, D. C.: U. S. Government Printing Office, 1965), pp. 8-9, 13.

30/ On the role of the Space Science Board in NASA policy-making, see pp. 154-55.

31/ Space Research: Directions for the Future (Washington, D. C.: National Academy of Sciences-National Research Council, 1966), pp. 3-4.

32/ Ibid., pp. 3 ff.

1965-1975 time period with roughly equal expenditure for each in the 1970-1985 period. The emphasis should be on "scientific mission capabilities." Anticipating larger payloads than could be carried on the Saturn IB-Centaur-based Voyager program, it recommended a study of the early use of the Saturn V in planetary exploration. The group ranked Mars as the first priority for exploration, with the Moon and Venus second; it thought also that from 1965-1985 "unmanned experiments will probably provide the most significant contribution to the program of planetary exploration."

On the other hand, a working group on the role of man in space research concluded:

> Scientifically satisfying studies of the planets will require the presence of scientists, preferably on the planetary surface where they can make direct observations. If that is not feasible they should at least be in a spacecraft orbiting closely enough to the planet so that communication time delay and power band width considerations will not seriously limit the performance of remotely controlled instrumented vehicles on the planet. It is clear that here man is essential.

Man could be "usefully employed in space for scientific research: as observers; for the assembly, placement, repair, and operation of scientific instruments; for preliminary analysis, screening, sampling, data collection, storage, and retrieval." It was said, however, that "few if any scientists would attempt to justify the entire cost of developing manned space flight solely on the basis of its 'scientific value'."[33/]

Concurrently with these variations in attitude on lunar versus planetary missions and unmanned versus manned explorations, there was considerable disagreement among scientists about the level of budgetary expenditures that should be allocated to NASA. Table II on the following page shows scientists' perceptions, by discipline, of the adequacy of budgetary support given to NASA.[34/]

Thus NASA moved into the period of political consideration of its post-Apollo program with a lack of unanimity in the science community on mission objectives and on the level of budgetary support. The same situation existed in another of NASA's clienteles, namely, contractors.

33/ Quotations are from Ibid., pp. 623-24.

34/ Table is from L. Vaughn Blankenship, NASA: The Scientific Image, Internal Working Paper No. 65 (a research report supported in part by NASA under Grant #NSG-243 to the University of California), April 1967, p. 27.

Table II

Disciplinary Self-identification	Proportion who said NASA's share of the total R&D budget in 1965: Should Have Been Higher	Was About Right	Should Have Been Lower
Astronomy	7%	60%	33%
Atmospheric and Earth Science	4	54	42
Biology, Life Sciences: Bio-chemistry Physics Genetics Micro-biology	4	33	63
Other	6	46	48
Chemistry	5	39	56
Engineering	5	57	38
Mathematics	0	45	52
Physics	3	45	52

Industry attitudes on a space program for the future were indicated in staff studies for the Subcommittee on NASA Oversight in 1965, printed in 1966 under the titles Future National Space Objectives and Apollo Program Pace and Progress.35/ One of Representative Teague's concerns in the latter study was the effect of the decrease in workload, which was beginning to occur in the Apollo program and would move steadily downward as the completion of the program was approached.36/ The presentations of the major contractors on the Saturn/Apollo hardware showed graphically the declines in personnel to be retained in this production. While the

35/ The first of these studies was printed as a Staff Study, U. S. House, Committee on Science and Astronautics, Subcommittee on NASA Oversight, 89th Cong., 2nd Sess., 1966; the second was a Staff Study for the U. S. House, Committee on Science and Astronautics, Subcommittee on NASA Oversight, 90th Cong., 1st Sess., 1967.

36/ Apollo Program Pace and Progress, pp. 15 and 303.

effects of disintegration of space teams was clear, however, evidence of prospective unemployment and, in some cases, of effect on the companies was not present. General Electric reported that its professional people would be absorbed in the company.37/ While adverse affects were obvious for most of the prime contractors and also were seen for some subcontractors, Chrysler reported on letters from its subcontractors that showed the impact on employment in their companies if there were no follow-on NASA contracts: "In a large majority of the cases, they say they have no impact. . . . Many of these contractors, right now, have a high workload out of the Department of Defense because of the Viet Nam activity."38/ It was evident that the strength of many contractors' interest in the space program in the years with which this account is concerned was affected materially by the lushness of opportunities for alternative work.

More significant, perhaps, was the lack of a unified opinion on what kind of space program NASA ought to conduct in the future. Such a lack of unity, when combined with the manned versus unmanned divisions in NASA, the separate emphases of the subcommittees in the House space committee, and the ambivalence of the science community, meant weakness in support for the space program.

As could be expected, the prime contractors producing the Saturn launch vehicles and the Apollo hardware expressed strong support for a future space program based on Saturn/Apollo hardware, including the emerging Apollo Applications program. But even in attitudinal surveys including manned space contractors, dissension on the kind of program the nation ought to have was evident. Thiokol Chemical Corporation was emphatic: "We feel that NASA's post Apollo plans, as presented to Congress just recently, are unimaginative. . . . NASA's future planning beyond the lunar landing is largely based on the utilization of Apollo hardware. . . . The development of new launch vehicle technologies is essential to retention of our position as a leader in space exploration."39/ Ball Brothers Company, Inc., interested in unmanned space exploration, expressed "anxiety over the imbalance that appears to be shaping up between the manned and unmanned portions of the program," and thought the "national space program would be enhanced by the development of standardized small spacecraft."40/ Similarly, Avco Corporation lauded the unmanned program

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37/ *Ibid.*, pp. 356-57.

38/ *Ibid.*, p. 167.

39/ *Future National Space Objectives*, p. 325.

40/ *Ibid.*, p. 220.

and favored planetary exploration that took advantage of the Mariner experience. It believed that "the desire of NASA to develop an improved Saturn launch vehicle as a means of keeping the Saturn design team together, while understandable, is probably premature during this era."41/ Martin Company, prime contractor in the program but not one of the prime contractors for the Saturn boosters, thought it was time for a "new configuration . . . /of/ second generation spacecraft."42/ Aerojet-General Corporation headed its guidelines for the future with emphasis on unmanned space exploration through the 1970's. It referred to "the natural and seemingly logical tendency to want to continue using existing hardware as long as possible," and feared "that the present attitude toward the extended use of some of our present costly and cumbersome space systems is not as wise and farsighted."43/

Coincident with this absence of consensus on a course of action for NASA was a further weakness in industry support for the civilian space agency. Industry was affected in far greater degree by military than by NASA expenditures. In 1966, NASA's portion of the total defense and space market (expenditures by NASA and DOD) was 11.6 percent.44/ In addition, since about 1965 there has been uncertainty among contractors as to how far the space program of the future would be a military rather than a civilian program. Reporting to Teague in 1965, Ling-Temco-Vought, Inc., said that "the future role of the military in space will materialize in the latter part of this decade," and Douglas Aircraft Company, Inc., predicted that an increase in space expenditures "can mainly be expected in the DOD program which will evolve from the MOL program."45/

Uncertainties about space programs existed also in public opinion. The Washington Post on November 1, 1965 reported a Harris survey under the headline, "Public Has Doubt about Space Program." The poll data, taken from a national cross-section, showed that by a margin of only 45 to 42 percent did the American people feel that the space program was "worth the billions of dollars it will cost to put a man on the moon."46/

41/ Ibid., p. 218.

42/ Ibid., p. 271.

43/ Ibid., p. 216.

44/ Murray L. Weidenbaum, The Military/Space Market: The Intersection of the Public and Private Sectors (NASA Economic Research Program, September 1967), p. 9, Table 2.

45/ Future National Space Objectives, pp. 268, 241.

46/ Louis Harris, "Public Has Doubts about Space Program," Washington Post, November 1, 1965, p. 3.

Meanwhile, occasional comments kept alive the idea that unmanned space flight was being neglected by the concentration on a lunar landing by 1969. This was the theme of a New York Times editorial lamenting, on the occasion of the cancellation of the AOSO, NASA's "irrational set of priorities."47/ Dr. Richard Weaver, former president of the American Association for the Advancement of Science, argued that the basic significant questions posed for a manned lunar expedition could have been answered in a $500 million program over a 5-year period, and that the most serious aspect of this was not the cost of the lunar expedition but the diversion of scientists and engineers from more productive fields.48/ Senator Douglas asked in Senate debate, "Why should we race to get to a place where neither of us gains by arriving there?"49/

Senator Smith had a different question, although she called it the same one: "For several years now I have asked the same question: 'What are our plans in space after the moon landing? What are we to do with the multi-billion-dollar space investment?' If there are any plans we are not informed what they are.'"50/ Thus, in 1965 NASA was faced with several queries: What is the proper role of manned space exploration? What is NASA's role in manned space flight development? And more urgently, one of its friends had posed the question: What are your plans? NASA was under pressure to define more specifically what it had set forth as vague possibilities, without definite recommendation.

NASA immediately moved ahead with its Apollo Extension plans. In August 1965 it set up as a division of the OMSF a Saturn-Apollo Applications Office for direction of programs in manned space flight that would utilize the capabilities of the Saturn launch vehicles and the Apollo spacecraft--whether these vehicles were surplus after the lunar landing or produced beyond the estimated requirements for this mission. The common term henceforth to be used for these programs was "Apollo Applications" or AAP (Apollo Applications Program), which took the place of Saturn-Apollo Applications Program--a description briefly used but obviously inappropriate when abbreviated as SAAP. Webb regarded the earlier term Apollo Extensions as inappropriate because of his desire to have a clear cut-off for Apollo within or near the projected $20 billion figure. As late as November, however, he was verbally telling Mueller that something like LEM Applications Office or LEM Integration Office should be used as the name to indicate that there was no shift in the

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47/ New York Times, December 17, 1965.

48/ The Evening Star (Washington, D. C.), December 15, 1965.

49/ June 18, 1965.

50/ June 18, 1965.

center of focus and that effective use was being made of resources. The choice of a name occasioned much discussion in NASA. The agency wanted to emphasize that it was an "application" of existing capabilities, rather than a new program. At this time it was anticipated that applications would be primarily through modification of the LEM.

In November there was further definition of responsibilities for AAP.51/ While the four major offices in NASA each still would have responsibility for originating, defining, and breadboarding experiments, OMSF would have responsibility for coordinating experiments to be carried on AAP missions. The Manned Space Flight Experiments Board, chaired by Mueller but with representation from offices other than OMSF, would select experiments for implementation. Payload integration in modifications of CSM for the program would be the responsibility of MSC; LEM integration responsibility would go to MSFC. MSC had this task for LEM in Apollo missions, but it was burdened with work on Apollo and MSFC had personnel available for it under its personnel ceilings. This was the first assignment to the Huntsville Center of work of a type normally done in Houston.

Interim Activity in Congress--Late 1965

Between the considerations of the FY 1966 budget in 1965 and the FY 1967 budget in 1966, the space committees in both houses of Congress took steps to be better informed on future space goals. The Senate committee in August 1965 held hearings published under the title National Space Goals for the Post-Apollo Period; the House Subcommittee on NASA Oversight directed its staff to prepare a study, printed in 1966 as Future National Space Objectives, which was based primarily on a staff conference of committee staff members with NASA personnel on September 2, 1965 and on inquiries in 1965 to industry and science spokesmen.

The Senate hearings began with a statement by Webb. Characterized by restraint, the statement included the view that "now is not the time to make firm commitments to undertake large new space projects on the order of Gemini or Apollo," but rather, in response to Chairman Anderson, to "the point that you and I have discussed many times as an on-going incremental system, that is where we learn from what we have and take another step forward based on using what we have, and thereby gaining the full benefit of the investment we have already made." He wanted "national decisions" and "national consensus" on which options and alternatives set forth in the Future Programs Task Group Report should be undertaken. This led to some discussion about Webb's meaning. Senator Smith said she was "not sure" what he meant by a "national

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51/ Memorandum from George Mueller to James Webb, transmitted by R. Seamans, November 18, 1965.

consensus;" to which Webb replied, "I am not sure you have got to have a full consensus," but "it is our obligation to put forth the full amount of data so that as many people can be with us as possible." When Senator Smith wondered whether this would come "through a Gallup poll, a Smith poll, or what poll," Webb answered that he wanted "these matters before the public so that they can debate it and discuss it." Senator Young noted that he could not recall even one letter approving his votes for spending billions for space explorations, and questioned whether they should be guided by public opinion. Webb now thought Young had "misread" his meaning and tried to explain it "precisely." His explanation used the example of Vice-President Johnson's obtaining the counsel of members of Congress before the manned lunar landing decision in 1961. Thus, "national consensus" in its "precise" meaning was the consensus characteristic of representative, rather than plebiscitary, democracy.

Webb's appeal was for consideration of the intermediate objectives in the Task Group Report, to which he referred often. He said he would prefer "to proceed with Voyager and do a fly-by in 1969 and a landing /unmanned/ in 1971" than "to start toward an objective of manned exploration of Mars at this time." But the chairman feared NASA's steps toward a manned mission to Mars without a decision on it, probably as a result of discussions that had occurred of using the Saturn V for Voyager (since the Saturn V was a larger vehicle than was needed for an unmanned Voyager mission). He questioned Webb for further assurance and he said later to Dr. Hornig, "I do, too--think the Voyager program is very important but I would hate to see that used as the basis to try to order hardware for a manned Mars landing, and that was the thing I was worrying about."52/

Both the Senate committee and the House staff received lengthy presentations on AAP from Mueller. He said that Apollo Applications was not as yet an "approved" program and that the level of funding proposed for FY 1967 was only to hold open "as many options as feasible until the Nation is in a position to select the next major space effort." The $41.9 million requested would be used to "initiate incremental funding for those long leadtime components and materials required to maintain the current Apollo production capability of six Saturn I-B launch vehicles . . . and eight spacecraft . . . ."53/ He set forth in detail five alternatives, shown here as Figure XV, on page 173A. The economic benefits emphasis, as one of the alternatives, would include weather and communications applications, a station to inventory earth resources; it also could include a permanent national security station. The cost would peak to $3 billion annually in the 1970's. The lunar emphasis as sketched

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52/ National Space Goals for the Post-Apollo Period, pp. 14 and 114.

53/ See summary at p. 14 of Future National Space Objectives.

FIGURE XV

MSF PROGRAM ALTERNATIVES

PROGRAM ALTERNATIVE	PRIMARY OBJECTIVE	PROGRAM EMPHASIS
1	Direct Economic Benefits	Extensive Earth Orbital Activities
2	Lunar Exploration and Science	Extensive Lunar Operations
3	Planetary Exploration and Science	Early Planetary Landings
4	Maximum Effort	Preeminence in Earth Orbital, Lunar, and Planetary Activities
5	*Balanced Program	Best Balanced Program Based on National Capability

*Cost-effective combination of economic benefits, lunar and planetary exploration, and science.

NASA MT 5-9591
8-23-65

Source: U.S. Senate, Committee on Aeronautical and Space Sciences, Hearings, National Space Goals for the Post-Apollo Period, 89th Cong., 1st Sess., 1965, p. 61.

would lead to $3.4 billion annually, planetary exploration to $4.3 annually after 6 years, a balanced program to $6 billion within 5 years. A balanced program projecting an orbiting station in 1972, a lunar station in 1975, near planet fly-bys in the late 1970's, and a manned landing on Mars in the mid-1980's could rise to an annual cost of $4.2 billion after 6 years. Timing of launches, of course, could vary costs.

Mueller added two things to previous statements in his presentation to the House committee staff. First, he said "we have also looked at what we can do with the spent SIV-B stage as a laboratory."54/ This would become a central part of Apollo Applications planning, and would extend capabilities beyond those possible from the LEM modifications that had been discussed in the Task Group report. He also presented a planning schedule for AAP showing flights beginning in 1970.55/ After the short-run objectives of AAP he saw the next step as the development of a space station. He emphasized the "commonality of the subsystems we are developing here for both Earth orbital and planetary operations."56/

The committees sought counsel from scientists. To the House staff Dr. H. H. Hess, chairman of the Space Science Board, wrote that "the choice of our future space program should be controlled by . . . that course which gives us the greatest scientific return." He did not think that a single goal, such as Kennedy set in 1961, could be "repeated," but that major goals should be unmanned exploration of the planets, continuing manned exploration of the moon, and an astronomy facility, probably in Earth orbit. There also should be a measured pace toward manned planetary exploration about 20 years ahead. Hess considered it "almost inconceivable" that manned exploration of the moon should not be continued.57/

Dr. Hornig thought that astronaut stay-time on the moon should be extended to a week or 10 days, but that lunar bases for longer stays were "quite unrealistic." He stated that the nation should not commit itself to earth orbital stations of great size, "beyond the capabilities of the Saturn IB," or beyond 45 days stay-time, for he had "not been made aware of potential uses for large manned space stations which would justify their costs." He noted that the Voyager project, developed in part in response to the 1964 summer study by the Space Science Board, but on manned Mars expedition he saw its cost as "of the order of $100

54/ Ibid., p. 73.

55/ Ibid., p. 113.

56/ Ibid., p. 73.

57/ National Space Goals for the Post-Apollo Period, pp. 106-13.

billion" and concluded: "If this estimate is anywhere in the right ball park, I can only conclude that at this moment there are a number of other national objectives that seem more urgent."58/

Congressman Teague, as noted earlier, also sought the views of aerospace industrialists, but the staff report concluded that in the viewpoints expressed by them "no single or multiple grouping of potential future missions readily evolves."59/

The conclusion was unavoidable: future plans on a post-Apollo manned program were on dead center in the autumn of 1965. NASA was noncommittal on choice among ill-defined alternative missions, but hopeful that production of Saturn-Apollo hardware could be maintained for uses yet to be determined. The President had recommended funds for keeping open the options for manned missions and for an unmanned planetary program, but funds for new booster development were restricted. Scientists were approving programs that offered scientific returns; industrialists were emphasizing those with utilitarian payoffs. A large space station was the major objective of OMSF beyond the short-run missions of AAP, but scientists were questioning the justification for its cost. A still more remote program, a manned trip to Mars, was under discussion; however, the President's science adviser saw higher priorities, in view of its cost, and Senator Anderson was concerned that money not be used for it without a definite commitment to it.

In this situation the House space committee's staff saw a need for "identification of a major new national space objective. . . to provide a framework for ordering the various possible missions" that were under discussion, including a manned planetary fly-by by the mid-1970's with a planetary manned landing by the early 1980's; in other words, "a rallying point" in which "a program of unmanned and manned missions could converge. . . ." Conscious of the fact that such a program was not accepted then by all, and emphasizing that Congress should participate in the decision of a future space program, it recommended "that NASA report to the Congress not later than December 1, 1966, its recommendation on possible major national space objectives."60/ Teague, in submitting the report, called for "positive, bold decisions on future national goals

58/ Ibid.

59/ Ibid., p. 37.

60/ Ibid., pp. xiii-xiv.

in space at the earliest possible time."61/ These statements, like those of Senator Smith, registered impatience with NASA's delay in defining goals.

While the Senate committee made no report, Anderson wrote to Webb on January 27, 1966 about the Senate hearings that were about to be published. He stated with respect to a new objective:

> There is considerable feeling that there is merit to establishing a major goal to serve as a focal point to stimulate and provide direction and cohesiveness for our future space program, just as the lunar landing goal unified the space effort since 1961. Rather than consisting of loosely related scientific experiments, the future national space program might be built around a central theme. Without such a theme, there are reservations that sustained public support and the efficient attainment of national space programs can be achieved.

He asked if NASA concurred with the Space Science Committee that the planets should be the next major goal, and said that, in any event, the firm conclusion was that it was too early for the nation to commit itself to any program for manned planetary exploration. With respect to the manned program presented in the AAP, he warned that exploitation of existing hardware should not prevent the development of new systems to advance technology and reduce costs of flights. While it was important to preserve momentum, this was not sufficient reason to continue the AAP; while it was prudent to utilize excess Apollo hardware, the committee was not persuaded toward procurement of additional hardware. He said the committee would want information in FY 1967 hearings on what AAP missions were proposed and what results were expected.

NASA's Position on Apollo Applications

One thing was apparent from all the discussion on manned space adventures in 1965: no one was ready for a new, long-term commitment similar to that in 1961 for manned lunar landing. First, all persons seemed to realize that it was not a propitious time for new starts. Webb had faced the necessity of budget reduction for NASA the preceding year, when President Johnson informed him that Senator Harry Byrd, chairman of the Senate Finance Committee, had told the President he would oppose a tax cut if NASA's appropriation were not reduced. He was cognizant now of other fiscal pressures: Congress had passed a number of "Great Society" bills in 1965 and the President's budget message in

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61/ *Ibid.*, p. 111.

January 1966 would call for a "significant increase in programs which attach urgent domestic problems;" the message also would state the need for an increase in appropriations for the Southeast Asia war from $4.6 billion in FY 1966 to $10.3 billion in FY 1967. Moreover, while some congressmen in occasional questions or comments stressed need for a commitment that would obtain public approval, others did not want to get boxed in where they could not ride with public opinion, as they had been with Apollo.

There were two possibilities for a long-range manned space objective. One was a Mars mission for the eighties, but its objectives were scientific and scientists were interested in what could be learned more quickly by unmanned exploration. The cost suggested for a manned mission appeared to be prohibitive unless technological breakthroughs to cheaper boosters were made. Anderson perhaps mirrored the feelings of friends of space adventure when he indicated that he might approve a manned Mars mission; but he also reported to Webb that it was too early for a decision of this kind, and that he wanted to avoid any foot in the door in this direction. Webb has stated that he did not consider seriously the Mars alternative and that he did not think the President did.62/ He said to the House space committee on March 10, 1966: "Projects such as a permanent or resupplied manned space station or a lunar base, or projects for manned planetary exploration, can await maturing of our operational, scientific, and technological experience."63/ But members of NASA's headquarters staff definitely were influenced by the possibility of a manned Mars mission, and other congressmen besides Anderson were interested in knowing what place it had in NASA planning.64/

The second possible long-run objective was a space station (a laboratory in earth orbit), perhaps revisitable over time by men and capable of carrying a variety of experiments on interchangeable modules. NASA was not prepared in 1965 to define either the technical makeup of a space station or the uses to which it would be put, but as time passed, discussion within the agency moved toward the idea of an eventual space station.

62/ Webb interview. Shapley, who moved into Webb's office from the Bureau of the Budget in September 1965, stated to one of the authors on May 28, 1970 that he does not recall any serious discussion of a manned Mars mission in the top level in NASA.

63/ U. S. House, Committee on Science and Astronautics, Hearings, 89th Cong., 2nd Sess., March 10, 1966, I, 8.

64/ See, as illustration, U. S. House, Committee on Science and Astronautics, Subcommittee on Advanced Research and Technology, Hearings, 1969 NASA Authorization, 90th Cong., 2nd Sess., 1968.

In this situation, the AAP offered itself as a program of opportunity. NASA's successes in 1965 led to the belief that there would be surplus launch vehicles (Saturn V's and IB's) from the Apollo program, yet neither the agency nor Congress was willing to gamble on this by reducing production schedules. Hence, alternative uses for the vehicles could be planned. Moreover, "follow-on" production of additional hardware, with spacecraft modified for the AAP, could keep the agency and industrial teams together. This might have payoffs in future space developments; it certainly had institutional payoffs for OMSF, for at least one manned space center, and for manufacturers of Saturn vehicles and Apollo spacecraft.

To NASA planners the equipment appeared to be adaptable to new uses. The initial idea was to modify the CSM and LEM for new missions. Subsequently, Von Braun suggested that the S-IVB, emptied of its fuel, could be outfitted in space as a laboratory and thus serve as an interim, or "poor man's," space station. Man's capabilities in space could be tested in its outfitting, and experiments of scientific or material value could be conducted. The LEM, CSM, and S-IVB offered a versatile set of spacecraft facilities.

Thus, the AAP could be a bridge, as it often was called. With Voyager it could be the intermediary program, with flights from 1968 or 1969 to about 1972. Time would be allowed for long-range planning and pragmatic data would be gained to provide a base for decisions.

But there was indecision on the "bridge." Webb could not allow the agency to promote new goals until the President's position was determined and announced. Hence, NASA's position was to keep options open for another year until the making of the FY 1968 budget, the deadline when it said decisions would be required. Two incidents in 1965 show the strains within the agency over this delay in decision. First, Mueller's staff had decided to meet the criticisms of manned space flight in the science community by a positive statement on manned flight through presentation of a movie to congressional committees. The key narrator of the 27-minute movie was Dr. Charles Townes, eminent scientist and chairman of Mueller's science advisory committee (STAC). The movie was prepared for presentation in consideration of the FY 1967 budget, but it was impounded at the Administrator's level in the agency and only released for presentation a year later. Second, Mueller's presentation for the FY 1967 budget initially was prepared with positive statements on what the agency was going to do in the AAP. This came back from the top agency offices with word that if the statement went out in this form somebody would be fired.65/

65/ Information given by several staff members in Mueller's office who assisted in preparation of data for congressional presentation.

This delay was accompanied by indefiniteness and lags in NASA planning. Congress persistently in 1965 and 1966 wanted definite information on costs of Apollo Applications. NASA in response gave only general estimates, under the assumption that the nation should support manned space flight on a scale at least equal to that currently appropriated. The latter was one of the assumptions given to the planners in Advanced Missions. Webb said in FY 1967 hearings that he visualized expenditures eventually equivalent to the Apollo program in annual costs. Mueller, also in FY 1967 hearings, said that the 1968 fiscal year costs would be about $1 billion. These costs were based on the 6-6-8 assumption of future hardware production. But the fact was that NASA could not state specific costs: (1) it did not know how much surplus hardware would be left from the Apollo program, and (2) the missions to be flown in AAP still were not fixed firmly.

On March 30, 1966, as has been noted in Chapter IV, Seamans gave a report to the four associate administrators on an Apollo Applications Status Review for the Deputy Administrator that had been held on March 11. The importance of the document was indicated by its distribution to a list of 57 persons, in addition to 10 persons on the "internal distribution" list. The report, it was stated, reflected "tentative planning information only";"the joint review presented by the Program Offices on March 11, 1966, has provided the first complete view of the Agency's total Apollo Applications activity." The report stated that there were three major candidates for AAP missions: (1) extensive lunar mapping, (2) earth survey by adaptation of the Apollo lunar mapping equipment, and (3) the Apollo Telescope Mount (ATM). Top priority was given to experiments for the first five AAP earth orbital flights, including ATM. The ATM was "being given top OSSA priority for definition and development because of its scientific merit and compatibility with the basic Apollo system."

The indefiniteness of mission plans in 1965-1966 was paralleled by delay in development of experiments and experiment packages to be carried on the missions. Seamans' memo stated the first two conclusions he had reported to Webb as a result of the conference on March 30: (1) the "pacing item in the AAP program" was the identification, definition, and development of experiments and experiment packages to meet the earliest possible flight dates, and (2) while many experiments were under study, only two small AAP experiments had been committed to development at that time. An attached staff memo referred to the gross mismatch between approved experiments and the great payload capacity provided by the Saturn-Apollo hardware.

Some large problems of significance were referred to in this packet of documents. The staff memo, showing consciousness of the other mismatch between production potentialities and mission planning, suggested that it might be in the national interest to preserve the production rate of the Apollo-Saturn hardware even though "we are unable as yet" to identify and obtain approval of specific missions that would use this equipment. Thus, it reflected the desire to hold the industrial team together and to maintain national capability. Seamans' memo also declared the necessity for "a clear and defensible rationale for the AAP missions."

Such a rationale was a problem that bothered Mueller as he prepared his presentations for Congress. He sought the aid of his staff and at times of a few social scientists within and outside the agency. In presentations on FY 1966 and 1967 budgets, he followed the line of Webb's February 1965 letter to the President that the nation should maximize the use of "flight hardware already in hand or underway" and continuously emphasize "the exploitation of these capabilities." But of what use was this capability? Mueller repeatedly presented earth orbital, lunar, and planetary alternatives, and in the absence of a choice spoke favorably of a balanced program, but he was unable to spell out the national payoffs from undetermined specific missions. He desired a planetary program (this would keep in operation the industrial team that he represented as the head of OMSF and also would satisfy the scientists), but the Voyager program was the immediate planetary program and Congress was fearful of commitments beyond it. Mueller, therefore, had to tell questioners in Congress that AAP was "not an interplanetary program."66/ A follow-up lunar program after the first manned landing seemed like a natural objective, but this single objective was not challenging at this stage.

Emphasis, therefore, was placed on the benefits from an earth orbital program. In November 1965 Mueller held a two-day meeting with Apollo executives in Phoenix, Arizona. The options on a post-Apollo program were debated and the sentiment was that real rewards could come from an earth orbital program. One of Mueller's top advisers has said that this was the real genesis of AAP as it was to develop after that time, with major attention to be given to earth orbital missions.67/ This adviser even said that this meeting "sort of closed the door on new systems." The earth orbital missions, however, would be planned to include a solar observatory (ATM), thus recombining planetary science with lunar science, earth missions, and biological tests of man's capability in space flight.

Organizational and procedural aspects of NASA complicated the development of an intermediary manned space program. There were some divisions between two of OMSF's centers. MSC was engaged too heavily

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66/ See especially Senate Space Committee, FY 1966 NASA Hearings, p. 856.

67/ Interview with Captain Robert F. Freitag, 1968.

in the Apollo program to have any major interest in spacecraft modifications for programs of small challenge, as the AAP appeared to its staff. It was interested in moving toward a space station outfitted on the ground. Marshall, on the other hand, needed new work, and Von Braun came up with the idea, promptly endorsed by Mueller, of using the third stage (IVB) of the Saturn V (and also the second stage of the Saturn IB) as a space station.

The Apollo Applications office in Washington operated in an atmosphere of uncertainty and restraint. Seamans' memo of March 30, 1966 stressed that all changes of Apollo hardware for AAP missions required approval by Webb or by him. "The required procurement approvals by the Administrator . . . and/or myself must be strictly observed, for this program is the Agency's major new business for some time to come." Ultimately, budget limitations, Webb's and Seamans' concern over the technical basis for AAP planning, and contractor problems after the Apollo 204 fire would lead to increased centralized control over the Applications Office's operations. A major problem was the coordination of experiments selection with mission planning, and of design adaptations of spacecraft for experiments. Experiments were brought forward from OSSA and OART offices, and these had to be fitted into AAP hardware and missions. The planning of missions and experiments for lunar exploration created special problems, for this typically involved scientists in OSSA, personnel in the Apollo program in OMSF, persons in Advanced Missions, and later the Apollo Applications Office. This particular problem of coordination would be resolved on January 4, 1968 by the creation of a separate Apollo Lunar Exploration Office within OMSF, which drew its staff both from OMSF and from OSSA and was responsible to OSSA for scientific aspects of lunar exploration. The lunar responsibilities of the Apollo Applications Office were transferred to this new office. In organization the two parts of Apollo Extensions thereafter would be separate; one would be called Apollo Applications, the other lunar exploration.

It was always difficult, if not impossible, to know precisely what funds were being used for the AAP. No one could determine what surplus of hardware would be transferred to it from the Apollo program. But beyond this, offices outside the Apollo Applications Office were devoting funds to experiment planning and to other activities that could have some relation to AAP.

The 1967 Budget

The 1967 budget was an interim budget, with decisions on post-Apollo programs deferred until the consideration of the 1968 budget. NASA, after preliminary submittals to BOB, was asked on August 27, 1965 to reexamine its estimates for FY 1967 within a level of $5.260 billion, which compared with $5.195 billion appropriated for FY 1966. A reply from Webb on October 1 reviewed the program objectives of NASA for FY 1967. The letter explained that NASA could conduct its present program with an appropriation of $5.020 billion, but that it desired "to provide a growing capability for future programs." For its "two major projects" it needed $146 million for Voyager and $264 million for Apollo Extensions (as it was then called). It also needed $137 million for other activities, including extensions of the SNAP-8 and 260" solid rocket motor "which we now believe to be desirable revisions of the phase-out objectives reflected in the President's FY 1966 budget." The letter stated that if the reduction to $5.260 billion were to be made, then current activities could be expanded only for Voyager and in a reduced commitment to advanced missions.

The data accompanying this letter outlined anticipated needs for "Apollo Extension Systems" as $264 million for FY 1967, $1068.7 million in 1968, $1913.1 million in 1969, and $1891.4 million in 1970; these sums would be supplemented each year by $10 million in Advanced Missions. The objective was a flight program, beginning in 1968, that would utilize the current production capability of six Saturn IB's, six Saturn V's, and eight CSM's and LEM's.68/

The President recommended to Congress a total NASA appropriation of $5.012 billion. The first Voyager flight would be postponed two years to 1973, and only $10 million for design studies was recommended for the project. For Apollo Applications $41.8 million was recommended for purchase of long-lead hardware items (follow-on production of CSM and LEM spacecraft and engines for the Saturn IB beyond Apollo program needs) to keep the options open for the alternate missions being planned. Related to AAP was a recommendation for $25 million to OSSA for manned space science. Small amounts were included for the SNAP-8 and the 260" solid motor. These and other budget constraints, amounting to a holding position on all future programs, led Webb to call this an "austerity" budget.69/

Webb, explaining this budget in 1966, told the congressional committees that various unmanned flights (Explorer, Surveyor, etc.) would be continued, but noted that the AOSO had been cancelled and that NASA would not be able to do all the things desired by the Space Science Board. A Mariner Venus mission in 1967 and a Mariner Mars mission in 1969 were planned. FY 1968 would be crucial: without initiation at that time of a Voyager Mars mission there would be no further planetary flights planned. And "perhaps the most critical gap we face is in the

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68/ U. S. Senate, Committee on Aeronautical and Space Sciences, Hearings, NASA Authorization for Fiscal Year 1967, pp. 149-150. (Hereafter cited as Senate Space Committee, FY 1967 NASA Hearings.)

69/ U. S. House, Committee on Science and Astronautics, Hearings, 1967 NASA Authorization, 89th Cong., 2nd Sess., 1966, Part I, p. 5. (Hereafter cited as House Space Committee, FY 1967 NASA Hearings.)

area of manned space flight," on which any important decision was deferred until 1968.

Mueller's presentations at this time developed the utilitarian and scientific payoffs that were possible from manned earth orbits. Weather could be forecast "more accurately over longer periods of time." Combined with lower earth orbits, "we could build a new climatology." The result could be "a savings of $2 to 2.5 billion per year in such U.S. activities as livestock production, fruit-vegetable production, new construction, fuels and electric power, and floods and storms." Also helped would be the tourist industry, commercial ships and aircraft, and commercial fishermen. Optical astronomy free of atmospheric distortion and filtering was anticipated; particular advantage could be taken of the 1968-1970 period of peak solar activity, which would not occur again for 11 years. Telescopes in the OAO project could be adapted for use in Apollo spacecraft with astronauts being able to adjust, calibrate, and operate the telescope. Communications payoffs could include direct broadcast of live radio and television on a world-wide basis from stationary positions far above the earth, and a navigation traffic control system. With long duration flight, earth resources could be mapped in minute detail from observation platforms. Better management of agricultural resources, controls over flood damage and snow cover and other conditions would be possible.70/ "I think it is clear that man is for the first time on the threshold of the ability to control his environment."71/ Lunar exploration would add knowledge on "the origin and the history of the moon." Biomedical experiments would monitor the effects of weightlessness on man's cardiovascular and musculoskeletal systems. Moreover, the capabilities of man to operate in space over protracted periods and his usefulness in such activities as adjusting telescopes and cameras could be measured.

Mueller very tentatively outlined the timetable for earth orbital and lunar missions in the AAP, and showed the expected capabilities for flights from 1968 to 1971 inclusive.72/ He said, "We may have the capability of placing astronauts in earth orbit for approximately 4 weeks by 1969 and by 1971 we may extend this time to 3 months."73/

70/ Ibid., especially pages 171-77

71/ Ibid., page 352.

72/ Ibid., pages 366-67.

73/ Ibid., page 175.

The missions in which this capability would be developed would make use of surplus hardware from the Apollo program and follow-on hardware, such as would begin to be purchased under the $41.9 million appropriation requested. Mueller revealed that this hardware had been developed initially with capabilities for future use in mind. A major factor, he said, in the selection of the lunar rendezvous was that it "would provide a powerful and flexible manned space exploration capability as a product of the Apollo program."74/ The S-IVB stage now offered additional capabilities.75/

While none of the future programs discussed by Webb were line items in the authorization, the space committees considered them separately. Webb's desire to have a debate and consensus on national capability was obscured in the discussion of separate items, as the committees sought detailed control of expenditures and compromise of differences within and between them. The House committee reported--strangely, in view of NASA's noncommitted position--"The exploration of Mars . . . is a project to which NASA is virtually committed." It thought "as much preliminary work as possible" should be done on a project (Voyager) on which the "taxpayer will be asked to invest $3 billion or more during the next decade," and unanimously approved an increase of the $10 million recommended to $22 million. Thus, it showed its approval of this major unmanned program that might become the basis for a manned program. The committee recouped $8 million of this $12 million by deleting the Venus project for 1967, which it said had been put in the budget only 3 months earlier, when the decision to delay Voyager for 2 years was made. It added $20 million for the inclusion of a Mariner atmospheric probe in the 1969 Mars flyby mission. It also increased the amount for the SNAP-8 program from $5.5 million to $7.9 million, and for the 260" solid propellant booster from $3.3 million to $11 million. The committee approved the $41.9 million for AAP, and said: "The possibilities are enormous, ranging through a multitude of proposals offering exciting hopes of accomplishment." With other adjustments, it recommended and the House approved an authorization equal to that recommended by the President. It may be assumed that the adjustments were the result of the influence exerted by subcommittees for programs in which each had an interest.

The Senate space committee was influenced strongly by the executive recommendation and those of the Space Science Board. It found that the budget requests represented "a very carefully planned and balanced program" at "minimum funding levels" for maintaining the space and aeronautics program. It held hearings to obtain additional data from

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74/ Ibid., page 165.

75/ Ibid., pages 373, 868-70.

the National Academy of Sciences. It noted that members of the National Academy and the Space Science Board had wanted a Venus mission and that the Soviets already had launched two Venus probes. It pointed out that the "Van Allen Report" to the Space Science Board had urged NASA to review less expensive spacecraft for planetary missions, but that NASA was planning to use the expensive Saturn V for Voyager by carrying two Voyager missions on one Saturn. The committee believed that "NASA should make every effort to get planetary information by less expensive means before embarking on an unmanned spacecraft as sophisticated as Voyager." Agreeing with two space science board recommendations, it thought that small spacecraft, such as the Pioneer, could be used in the interim for planetary probes. The Senate accordingly disapproved all the House committee changes in amounts for Venus, Mariner, and Voyager, as well as for SNAP-8 and the 260" motor.

In the conference committee the Senate accepted a $13 million addition for Voyager; the House receded from its changes on the Venus and Mariner projects; and the Senate accepted $2 million of the $4 million increase for SNAP-8 and $4 million of $7.5 million increase for the 260" motor added by the House. While these differences between the committees revealed the uncertainties about future programs, both committees and both houses accepted the President's recommendations on authorizations for or related to AAP and the total authorization approved was less than $12 million below that recommended by the President. The appropriations committees made some reductions, and the amount finally appropriated was $4.968 billion, a reduction of $44 million from the President's budget. While there was dissatisfaction expressed about parts of the budget and about administrative matters, the executive program recommendations, proposing as they did limited programs and deferring major decisions, stood up with only minor change in Congress.

Nevertheless, dissatisfactions, some of which imperiled NASA's manned space program, were present in Congress. Among the general dissatisfactions uncovered was NASA's transfer during the preceding year of $20 million from R&D to Administrative Operations, which action Congressman Daddario suggested was contrary to congressional intent; the geographical distribution of contracts;76/ and the location of the Lunar Receiving Laboratory at Houston. Ranking Republican congressmen on the Space committee--Rumsfeld and Fulton--vigorously attacked this decision in special hearings on it. There were dissatisfactions related directly or indirectly to manned space flight. Daddario's preference for manned flight was indicated: "Wouldn't there be more public support, for example, for a program to put a man on Mars as opposed to a program

76/ House Space Committee, FY 1967 NASA Hearings, Part I, p. 525.

involving just machinery into a Martian atmosphere without the use of man?"77/ But Congressman Heckler, chairman of the House Subcommittee on Advanced Research and Technology, wanted to know whether Mueller would object to additional funds for the SNAP-8 and 260" motor programs, and thus indicated the competition for space funds for different purposes.78/ The Senate space committee thought that facilities and personnel for OSSA and OART were sacrificed to OMSF's needs.79/ There was much concern over the relation of DOD-MOL and NASA programs, and whether there was indeed duplication. The pressure for more specific information on costs of AAP, previously referred to, existed in both the House and Senate space committees.

Two kinds of dissatisfaction, however, were of particular importance. One was the feeling that NASA was not providing sufficient help to Congress on post-Apollo decisions. James J. Gehrig, Staff Director of the Senate space committee, recalled the statement in the Senate space committee report of the preceding year "that NASA should say what projects it recommends and why." He asked Mueller if it wasn't necessary for the President and Congress to be given "some criteria" for judgment on future goals. Senator Howard Cannon (Dem., Nevada) was insistent:

> I do not think it is fair for NASA to come up and say, "These are the capabilities we have and you people decide what the goals are." This is a new switch. As a member of the Armed Services Committee, they come up and tell us what they propose, not what their capabilities are, and let us decide what we want to do. As a matter of fact, we try to decide and try to shove it down their throats occasionally, without much success.
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> I think that NASA should come to us with some goals that they should recommend and let us examine them and see if these are national goals that we want to carry out.80/
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> . . . .

77/ *Ibid.*, p. 266.

78/ *Ibid.*, p. 187.

79/ U. S. Senate, Report No. 1184, 89th Cong., 2nd Sess., May 23, 1966, p. 25.

80/ Senate Space Committee, FY 1967 NASA Hearings, p. 119.

> I would like to ask Dr. Mueller or Dr. Seamans, would you give us a flat yes or no on the question of whether it is the responsibility of NASA to make specific recommendations to this committee on post-Apollo programs?81/

Chairman Anderson said he wanted "to echo what Senator Cannon had said." And the House space committee asked "that definite plans for Apollo Applications be submitted to the Congress well in advance of the submission of the NASA fiscal year 1968 authorization request to allow for orderly program review . . . ."82/

While NASA could meet this demand for definite plans in a program to be approved by the President in the FY 1968 budget, it faced a more formidable and threatening reaction, presaging trouble in the future, from Congressman Fulton. His positions were indicated in the hearings, but summarized forcefully in dissenting views in the House space committee's report.83/ They constituted a frontal attack on the premises on which the manned space program of the nation was based. He recommended the deletion of the $41.9 million requested for AAP procurement and a substantial trimming of the authorization for the "blue sky" thinking of the Advanced Missions unit in OMSF. In part, his objection to AAP was based on its failure to show "how many boosters, spacecraft, and hardware" would be needed for the program, and to supply "any information on the number of Apollo Application flights, their purposes, missions, or destinations--absolutely nothing." NASA's plans were "so indefinite" that they could not "be considered as substantive factors by Congress in reaching a decision. . . ." But his objections went deeper. He feared that "the present generation of boosters, spacecraft, and hardware, as well as fuels, would look like 1914 Fords by 1970." Maintaining production of existing hardware to keep "open options" was "really expensive theory." He had favored the committee vote for additional funds for "high energy propellants, large solid rockets, and nuclear propulsion." NASA had altered its basic objectives. Created to be an R&D agency, it "is now settling down to become primarily a manufacturing, production and engineering operation. . . . In fact, I consider that only about 5 percent of the total current NASA budget request is to be devoted to science, research and development." At the same time, he criticized the Administration's decision on MOL,

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81/ *Ibid.*, p. 130.

82/ U. S. House, Report No. 1441, 89th Cong., 2nd Sess., April 20, 1966, p. 111.

83/ *Ibid.*, pp. 121-33.

which he thought should be under the jurisdiction of NASA or of NASA and the Air Force jointly. He quoted Congress' intent in the Space Act "that activities in space should be devoted to peaceful purposes for the benefit of all mankind" (Fulton's emphasis). "Is the Presidential order the beginning of a new military era in space?"

Fulton expressed other views, which may have reflected in some instances, or in some measure, his role as ranking minority member of the committee. He was concerned about field monitoring of NASA activities. The BOB had "far too few people with far too much control over the NASA budget." The General Accounting Office "had yet to provide Congress" with meaningful reports. There was need for "technically qualified people to oversee technical programs," and for this purpose the space committee needed additional technical and scientific staff. Secondly, because the "current NASA program is replete with a myriad of complex and sophisticated projects designed to meet a wide variety of objectives of importance to the Nation," the Administrator of NASA should have an inspector general "with the capability of obtaining independent evaluations and examinations of management actions by personnel other than those involved in formulating or implementing management policies." There also were attacks on the location of the lunar receiving laboratory and on the "unbalance" in geographical distribution of NASA contracts. On the latter, Congressman Vivian likewise wrote a protest.84/

84/ Ibid., p. 120.

CHAPTER VI

POLITICAL CONSIDERATION OF MANNED SPACE ISSUES: COMMITMENT, DEBATE, AND STALEMATE

The time had arrived in 1966 for specific plans and debate on manned space flight decisions. The House space committee, reflecting both Senate and House opinion, had demanded that specific plans be brought to Congress by December 1, 1966. In this instance decision would travel through the entire series of forums into the administrative-political institutions of government (bypassing only the judiciary) and climb to an apex in congressional floor debate, maneuver, and vote.

It is important to understand the time frame. In spite of the feinting of NASA toward Congress and the sparring of Congress with the agency through two special studies in Congress and two budget deliberations, only 18 months had separated Webb's tentative suggestions to the President in February 1965 and the beginning of serious discussions between NASA and the BOB on the FY 1968 budget in August 1966; only 12 months had passed since NASA's creation of an AAP office.

NASA's position on AAP was now definite and, by the second half of 1966, was adjusted to political possibilities and to agency capability. In the beginning it had assumed a funding level equal to or higher than the Apollo peak and the maintenance of production of existing hardware, and had scrambled plans for missions and experiments to make use of that capability. By the second half of 1966 it had a firmer grasp of capabilities; it visualized use not only of the CSM-LM but also of the Saturn IVB as a workshop, and conceived also of the ATM for solar observation. It also was able to define missions making use of this capability very specifically, and to pare its cost estimates to levels acceptable to the President.

It submitted to the BOB a specific flight pattern for AAP covering the five-year period, 1968-1973. "The basic purposes of the Apollo Applications program," it said, "are to continue without hiatus an active and productive post-Apollo program of manned space flight, to exploit the capabilities of the Saturn Apollo system for useful purposes and to effect a progressive development of these capabilities as a stepping stone to whatever programs lie in the future."1/ At the heart of the

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1/ Budget Submittal, November 1, 1966. A complete review of the AAP as planned at this time can be found in U. S. House, Committee on Science and Astronautics, Subcommittee on Manned Space Flight, (Cont'd on next page.)

plans was the extension of the duration of manned flights from 14 days to one year. The missions were bracketed by five "reference" types:

1. Earth Orbit, Low Altitude, Low Inclination
2. Earth Orbit, Low Altitude, High Inclination
3. Earth Orbit, Synchronous Altitude
4. Lunar Orbit
5. Lunar Surface

The missions would allow progress toward three objectives:

1. Long Duration Flights
2. Manned Astronomy from Orbit
3. Extended Lunar Exploration

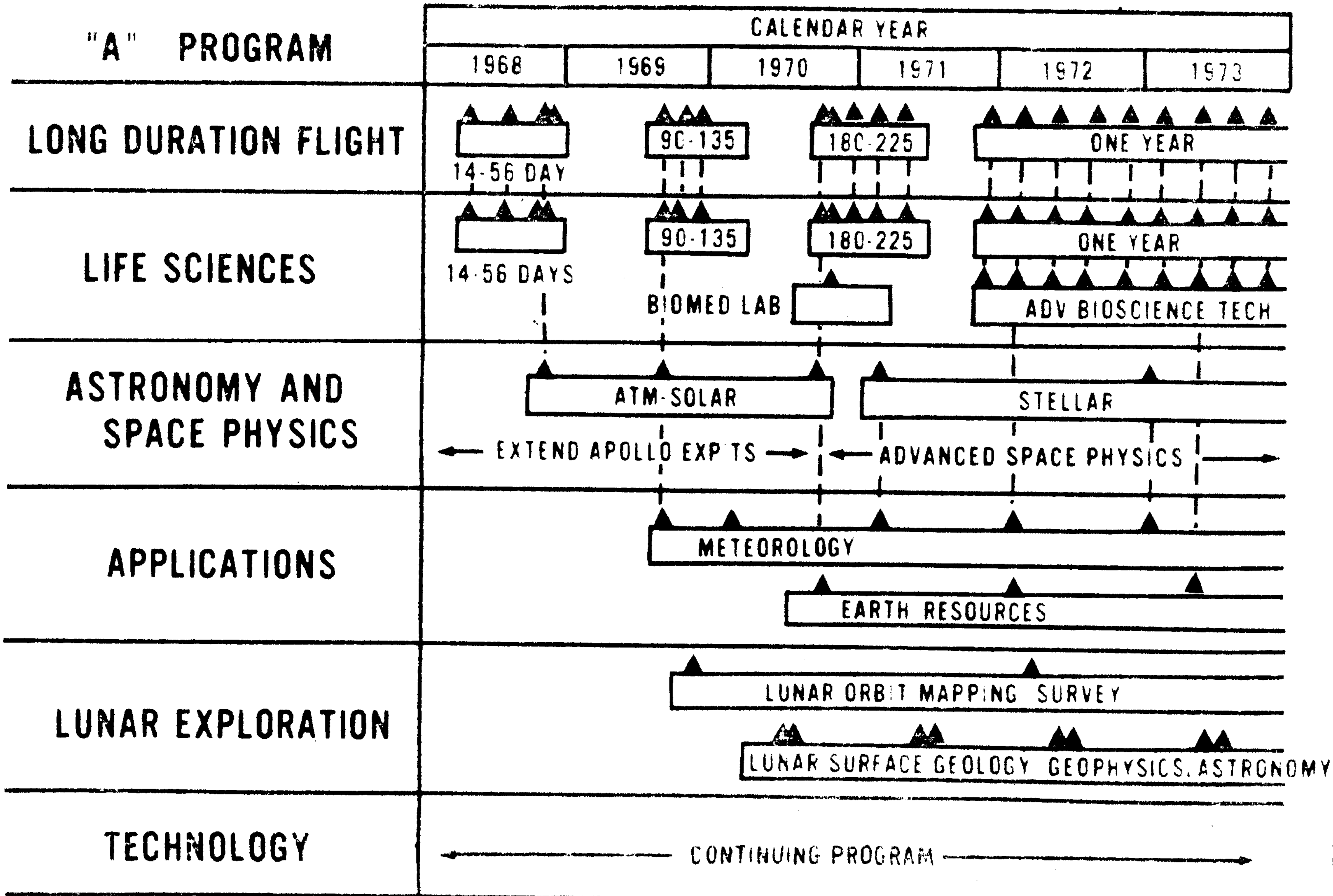
The total objectives were outlined in an attachment presented here as Chart X. A flight schedule was outlined year by year. The Saturn IVB would be the key element in 1968 missions. First, there would be two flights to evaluate the workshop and man's capacity for a 28-day mission. The S-IVB with an Airlock would be launched unmanned, and a 3-man crew on the CSM-LM would be launched separately. The crew would rendezvous with the S-IVB-Airlock and set up habitation and tests within it. The S-IVB-Airlock would be left in orbit for a return visit. Second, two flights would conduct ATM solar astronomy and achieve a 56-day mission duration. One flight would send up the astronauts in the CSM, a second the ATM-LM spacecraft. The CSM would rendezvous with the ATM-LM and then dock with the workshop, which would be reactivated as a habitable environment for the conduct of solar observation. In 1969 flights, lunar mapping and survey would begin, a second solar observatory would be launched, and experiments conducted on the workshop over a 90-135 day period (using three 45-day spacecraft for a 135-day mission).

The hardware to be used on each flight through 1973 was specified. Continued production of Saturn IB's and Saturn V's on a schedule of approximately four a year would be required. The Airlock for the S-IVB was already under contract for delivery in early 1968, and MSFC was developing the ATM for 1968-1970 use. The appropriation requested for FY 1968 was $626.7 million, and projections for the future ranged upward from $1,392.3 million in FY 1969 to $2,159.8 million in FY 1972.

1/ (Cont'd.)
Hearings, 1968 NASA Authorization, 90th Cong., 1st Sess., Part II, pp. 125-56. (Hereafter cited as House Space Committee, FY 1968 NASA Hearings.) Other manned space opportunities are discussed on succeeding pages devoted to Advanced Missions Studies, including at pp. 174-78, objectives and flight opportunities for manned Mars-Venus reconnaissance.

CHART X

APOLLO APPLICATIONS MISSION OBJECTIVES



Source: Apollo Applications Program, Budget Submittal, November 1, 1966.

NASA HQ ML66-9497
10-25-66

The BOB staff began its deliberations on NASA's budget in an atmosphere of budget stringency, with concern over a future manned space program that had theretofore not been spelled out, with uncertainty as to the relationship between NASA's program and the MOL, and with questions concerning the timing of AAP flights before the first Apollo flights.[2] At the Bureau's preview on the NASA budget the basic question raised was, "What will be the national posture on future manned space programs."[3] Questions outlined for inquiry, in addition to the U.S. posture with respect to the USSR on space activity, were in three categories. The first was on manned space goals: Should the nation commit itself to a manned Mars mission at a specified date? Should plans be made with a manned Mars mission as an option without a public commitment at this time? Should plans be made around transitional objectives without regard to a Mars landing mission? The second was whether, if manned flight continued, unmanned flights should be abandoned to the extent that their experiments could be carried on manned flights. The third were two economy issues: delay of the Apollo delivery dates, and use of the Titan III-MOL hardware for NASA's follow-on manned program.

At the preview five NASA plans with totals from $5.6 billion to $6.2 billion were reviewed and it was estimated within the BOB that with a stretch-out on Apollo deliveries and maximum abandonment of unmanned flights, the estimates could be reduced to $5.176 billion. NASA was given in August a guideline figure of $5.150 billion but was asked also to consider a maximum of $5.012 billion. In discussions of the BOB director with Webb one matter was disposed of first, namely, that no commitment to a manned Mars landing would be made in the FY 1968 budget. Fiscal constraints produced by high priority expenditures militated against new starts of this magnitude. Moreover, "for policy reasons," Webb did not find acceptable any slippage on Apollo deliveries. He felt it was essential to maintain booster production and the AAP program, and came back to the Bureau on November 3 with three alternative budgets, for $5.428 billion, $5.150 billion, and $5.012 billion, respectively.

BOB pressures led to further studies on AAP and the presentation to the Bureau by NASA on November 1 of four alternate plans for AAP. The first was that summarized at the beginning of this section and was called the A plan; as was noted, it called for $626.7 million funding.

2/ Interview with Donald E. Crabill, BOB staff member, September 10, 1968.

3/ Discussion on the preview and subsequent BOB actions is based on BOB documents.

It would have breached the $5.150 billion guideline. The B_{11} plan called for funding of $457.4 million, and would enable NASA to stay within the guideline. The B_{11} plan differed from A in that there was almost a 50 percent reduction in experiment definition and development, including reduction in earth orbital surveys; a delay from 1970 to 1971 in initiation of the extended lunar surface exploration; a delay from 1970 to 1971 in the first manned synchronous mission; and "reduced confidence" as the result of going to minimal development verification testing. Plans B_1 and C cut the programs drastically. Both allowed the four 1968 flights to be carried out on surplus IB boosters. Plan B_1 was built on an AAP/Titan III-MOL study completed in October, and contemplated substitution of the Titan III-uprated MOL for the Saturn IB in low orbit flights after 1968 but with delay of such flights for three years. Plan C would bring the budget down to a $5.012 billion goal but at the complete sacrifice of the earth orbital program for three years after 1968.

The BOB staff on NASA's budget noted in its reports that Webb considered the B_{11} plan a workable alternative, though with reduced confidence. The staff analyzed the AAP-MOL study report. The NASA budget group supported the B_{11} plan, though with note of the reduction in degree of confidence, and it was approved also by the Military Division in the BOB.

The foregoing discussion shows that NASA was committed to continuation of a manned space program, that the President accepted this, and that the issue was the amount of money that could be given to it. In saving the AAP, NASA gave up all Surveyors and Orbiters (all unmanned lunar exploration) beyond the seven and five, respectively, already contracted for, one-half of its sustaining university program, the request for $100 million for space station development, the 260" solid rocket motor, and the NERVA II (though it hoped to get this added later after joint AEC-NASA presentations). It retained, however, the Voyager program, a new Mariner mission for 1971, and certain other new unmanned programs.

The BOB was cognizant of a draft study report, called the PSAC Report, being prepared by a Joint Panel on Space Science and Space Technology of the OST and PSAC. The BOB staff noted that while most of the panel recommendations were long-range, it called for an unmanned Venus mission in 1970, which NASA did not include. The staff also noted that there were reservations in the report about AAP planning to date. In addition, the President's budget was prepared in a background of dissatisfaction over other budget reductions. A conference of mayors with the President on October 15 had presented their claims; on December 6, Detroit Mayor Jerome P. Cavanaugh, president of the U. S. Conference of Mayors, wired the President that "the space and hardware side of the economy continues to act as if there were no war on" and that the cuts made in low-income housing, poverty funds, and education "could be put back into the budget by delaying our arrival on the moon by about 44-1/2 working days." While Cavanaugh's assumption that a day's delay in the lunar landing would save 1/365 of NASA's total annual budget was unreal, the telegram, as did the scientists' views, showed the hostility that lay ahead for the NASA budget.

The President's budget recommended $5.050 billion for NASA; an additional $60 million was available from 1967 funds withheld by the President. AAP now had the President's approval and was included as a new line item at $454.7 million; Voyager, as the result of Senate demand also a new line item, at $71.5 million. The SNAP-8 was included but not the solid rocket motor. In spite of the House space committee's request for NASA's earlier submittal of plans on AAP it waited for the President's budget to go to Congress.

In line with its usual practice, NASA followed the President's message to Congress with a briefing for the press on January 21, 1967. In this case, however, an additional briefing of the press on AAP was presented on January 26. Background material was distributed, slides were shown, and Mueller answered questions at length. Apparently, the favorable moment had arrived for Webb to move forward with national debate and Mueller to press, without past inhibitions, his arguments for AAP.

Interim Events

An immediate event now clouded the future of AAP. On January 27, one day after Mueller's press conference, as Webb and the Vice-President sat at a luncheon with corporate executives and other participants in the space program, Webb received by telephone the message that a fire in a command module on a launch pad at the John F. Kennedy Space Center had taken the lives of the three astronauts within the module. This incident, called the Apollo 204 accident, was followed immediately by the appointment by Webb of a review board and by a study and hearing by the Senate and House space committees. The general conclusions were that the test conditions had not been recognized as "extremely hazardous" and that adequate safety precautions had not been established.[4]

The fire had a number of significant effects. First, it lowered the confidence of Congress in NASA and in the success of the Apollo mission and strained the good relations that had existed between NASA and congressional committees--leading even to some feeling that NASA was not reporting adequately and candidly to the committees. Second, it imposed additional costs and delay in the Apollo program, as corrections to insure greater safety were made in the Apollo spacecraft. The schedule for the first manned Apollo flight slipped about twenty months--from February 1967 to October 1968.

4/ See U. S. Senate, Committee on Aeronautical and Space Sciences, Apollo 204 Accident, Report No. 956, 90th Cong., 2nd Sess., January 30, 1968.

Third, it had momentous effects on the AAP contracts for modifications of Apollo spacecraft for the AAP would be delayed pending North American Rockwell's success in making the Apollo CM trustworthy; AAP flight schedules would be timed to later dates because of delays in Apollo flights; and there would be greater uncertainty on the amount of surplus hardware to be left from the Apollo program.

Another event was the issuance in February 1967 of a comprehensive report by PSAC on The Space Program in the Post-Apollo Period.[5] It was shown in Chapter IV that PSAC questioned the emphasis in NASA's program on manned space flight, and that it criticized also technical features and NASA planning with respect to innovations in the AAP--notably in the LEM/ATM and S-IVB projects. Thus, at the moment when NASA was asking for commitment by Congress to the AAP, the science community was indicating a lack of enthusiasm both for it and for emphasis on manned space adventures. NASA, in other words, lacked the benefit of united and forceful clientele support.

Rough Sledding in Congress

Along with AAP and Voyager, there was a third new element in the President's space program in 1967. In a special message to Congress on February 28, 1967, the President recommended funding for joint development by NASA and AEC of a flight-rated nuclear rocket, called NERVA II. The NERVA II, as an upper stage of the Saturn V, could double its propulsion capacity. The NASA budget recommendation was increased by $50 million, $27.5 million under the R&D appropriation, and $22.5 million for construction of a nuclear rocket testing station in Nevada.

In his presentation to Congress, Webb explained the five features of the budget for (1) carrying the Apollo to completion; (2) following up this with the AAP; (3) practical applications of space know-how in meteorology, in communications, and in other Earth-oriented applications, using the capabilities of the AAP and the unmanned Advanced Technology Satellite; (4) the Voyager program with the first objective of unmanned landings on Mars in 1973 and 1975; and (5) beginning the development of the NERVA II.[6] New Programs for unmanned space flight

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5/ President's Science Advisory Committee, The Space Program in the Post-Apollo Period, Report prepared by the Joint Space Panels and released by the White House (Washington, D. C.: U. S. Government Printing Office, February 1967).

6/ U. S. Senate, Committee on Aeronautical and Space Sciences, Hearings, NASA Authorization for Fiscal Year 1968, 90th Cong., 1st Sess., April 18, 19, and 20, 1967, Part I, pp. 10-11. (Hereafter cited as Senate Space Committee, FY 1968 NASA Hearings.)

were explained as including, in addition to Voyager, a Mariner Mars flight in 1973, a small space probe called the Sunblazer ($2 million), and a new family of applications satellites ($15.7 million).7/ Associate Administrator Homer Newell explained that there was some phasing down of other unmanned activity to make way for Voyager.8/

There was some rationalization of the space program, and of AAP in particular, in general terms. Webb said, "But I do not think there is anything more important than to realize we are building unlimited tools."9/ AAP was "a sort of interim use, . . . a limited incremental use of what we have, an expansion of it."10/ Seamans said its advantage lay in its "dual nature": it was designed to use developed hardware and experience, and to provide information necessary for future decisions.11/ He also saw the "dual nature" in taking advantage of hardware and experience and in unique practical applications, scientific knowledge, etc.12/ Mueller thought it was "essential to maintain this production capability in order to maintain the group of people that are needed to support the basic Apollo program as well,"13/ but this was an instrumental objective and program objectives were summarized as "Reasons to Support Manned Space Flight Program":14/

Maintain orderly pace of our progress
Guard against technological "surprise"
Maintain competitive position in the world market place
Support research and development vital to security
Avoid dissipation of space capability
Hold opportunity to return direct benefits to man
Take advantage of opportunities for expansion of knowledge
Provide the means to meet the challenge of the future at modest cost
Provide the capability to expand our space activity if international situation should change

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7/ *Ibid.*, p. 57.

8/ *Ibid.*, p. 273.

9/ *Ibid.*, p. 45.

10/ *Ibid.*, p. 34.

11/ *Ibid.*, p. 69.

12/ *Ibid.*, p. 96.

13/ *Ibid.*, p. 127.

14/ House Space Committee, *FY 1968 NASA Hearings*, p. 59, Figure 25.

There seemed to be no feeling in this Congress that NASA had not adequately presented goals for consideration. While at the beginning of the Senate hearings Anderson saw only "a little more definiteness," Senator Cannon thought NASA had given "very definite recommendations" in response to the past congressional requests.15/ Subsequent presentations by Mueller were quite specific on flight plans in AAP,16/ and the same presentation was given to the House committee. Presentations on other programs were equally specific.

Yet more than program definiteness now was required for favorable congressional response to the President's space program. The program was face to face with high priority claims on the federal budget. Senator Len Jordan (Rep., Idaho) reminded Webb at the beginning of Senate space committee hearings of the situation now confronting Congress:

> . . . I am a supporter of your program back through the years, one who is tremendously concerned and interested in your future program. We live in a world of realism, we live in a world where hard choices have to be made. We in the Congress must finance a war in Vietnam, as you know, that is costing upward of $2 billion a month. We know there are tremendous pressures building up for more very costly social legislation. We know that as a result of our present commitments, we face a very heavy deficit. So we hear talk in the Halls of Congress, and certainly when we go home, we hear talk of why we do not cut the space program. . . ."17/

Questioning from the beginning in the Senate committee reflected a realization that major curtailments of the space program might be made in Congress. Senator Cannon of Nevada, a state earmarked for NERVA facilities, was concerned over what NASA would do if Congress cut out the last two of the five program elements--Voyager and NERVA. Senator Jordan assumed that "logically" Apollo and AAP would have first priorities but wanted to know Webb's priorities. Webb refused to be trapped into conceding that any of the programs could go. Senator Spessard Holland (Dem., Florida) commented on the lack of support he discerned among Senators for the space program. As a Senator from a state favored by Apollo expenditures, he feared a cross-the-board cut in space authorizations. He hoped Congress could apply cuts "in a more intelligent way,"

15/ Senate Space Committee , FY 1968 NASA Hearings, Part I, pp. 16 and 36.

16/ Ibid., pp. 117, 194 ff.

17/ Ibid., p. 42.

and wanted clear breakdowns on specific items for use in explaining their relative importance. He wanted specifically to know whether there was any direct relation of the Voyager to the Apollo moon shot; and while Webb saw a connection between Voyager and keeping Saturn V production going[18] and Mueller a relation between this production and maintaining a team for the lunar expedition, Newell responded with a clean "no" to Holland's question. Anderson showed concern about Voyager's ultimate cost, for which $71.5 million was requested in this budget: "You spoke about Voyager. It only started at $1.3 billion. It is up to $2.2 billion now. It may be what, $10 billion in the end." Committee staff director Gehrig asked some questions about production rates and AAP. He wondered what the effects would be if the planned production of four Saturn IB and four Saturn V launch vehicles per year were reduced to a lesser number. He also asked for information on the cost of flight hardware for the first four Apollo Applications missions, and whether it would make sense to go ahead with other aspects of AAP if Congress reduced the funds for launch vehicle production.[19] There were, in other words, questions relating to whether AAP could be cut back. No questions, however, were raised about whether the various cost estimates were beyond what was required for the programs. One staff member in the Senate space committee remarked to the authors that the committees could not second-guess the agency on costs.

In the House space committee there was some interest in whether cuts could be made in AAP. Fulton wanted to know whether $454.7 million was a tight figure. Since $124.1 million of this was for Saturn IB and Saturn V production, there were questions about the possibility of reducing the production rate on these. Mueller's response was that the per unit cost would be increased greatly if less than four each were produced annually, just as he had said in the FY 1967 hearings that six per year was a more economical rate of production.

Besides these general inquiries related mainly to factors of cost, there were searching questions on technical and policy questions affecting AAP. Senator Smith announced at the beginning of the hearings that she would be interested in the coordination within NASA between manned and unmanned space efforts. She wondered whether man could play a significant role in space activities. While NASA wanted to answer this by testing man's capacity for long-duration flight, she thought that the question could "be answered only after we obtain results from our unmanned

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18/ In response to a question from Cannon, Webb made the following statement: "So I think the Voyager program, with its continuing development of the use of the Saturn V for unmanned flights, is extremely important." *Ibid.*, p. 39.

19/ For Cannon's and Jordan's questions, see *ibid.*, pp. 36-48; for Holland's, pp. 46-47, 145-48, and 286; for Anderson's, p. 41; for Gehrig's, pp. 148 ff.

missions to the planets."[20] There were questions showing interest in whether surplus Apollo hardware would be available, but, on the other hand, whether early AAP launchings would interfere with the Apollo schedule.

There was considerable concern about the relation between DOD and NASA planning. The Senate space committee held separate executive hearings on the Titan III-MOL. NASA entered in the record conclusions from the DOD-NASA 1967 study that the BOB had relied upon--conclusions unfavorable to substituting the Titan III-MOL for AAP. Mainly, the argument was that there would be a delay, occasioned by the time required to develop the MOL system and to integrate it with NASA systems, of perhaps three and one-half years; that while there would be some ultimate savings in cost, the non-recurring costs for systems integration and modification would increase materially costs in early years and the cross-over point to savings would occur several years down the line; that the results from the Titan-MOL would be less because of its limitation to a two-man crew, its limitation to low-earth orbit, and the loss of the opportunity to use and reuse the S-IVB for experimentation.

The PSAC report, by now printed, also led to many questions. Senator Smith asked that NASA's views on each of the PSAC recommendations be put in the record. Inquiries centered mainly on PSAC's reservations about the ATM and on the relative advantages of the AOSO (unmanned advanced observatory) and the ATM.[21] NASA replied that AOSO had been dropped because its heavy costs were concentrated in the FY 1966 and FY 1967 time frame. The cost of the first ATM was given as $38.4 million and including launch cost as approximately $130 million.

The effects of the 204 fire on scheduling and costs were of paramount concern to committee members. On April 24 Mueller submitted a statement on this to the House committee in executive session.[22] The fire had led to some reprogramming of AAP missions. The Workshop and ATM missions would be pushed forward from 1968 to 1969. However, a new 1A earth orbital mission now was planned for flight in the fall of 1968. While not stated specifically in this presentation, the 1A flight would become of importance as an earth applications mission.

Committee hearings are not the stage for a debate on issues. Unfortunately for the researcher, these debates occur in the closed

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20/ Ibid., p. 8.

21/ See Chapter IV, pp. 146-48.

22/ Printed in House Space Committee, FY 1968 NASA Hearings, Part II, pp. 1415-25.

sessions of committees. One usually can learn of the results, if at all, only as these are revealed in committee reports. The House committee left the recommended program intact, added $10 million to the sustaining university program and $12 million for the large solid rocket motor, and trimmed other items to produce a budget about $108 million under the President's recommendation. It declared that the AAP "represents an effort even more important and far-reading /sic/ in its implications than the Apollo effort upon which it is based,"23/ and trimmed the AAP by only $10 million. The Senate committee, which so fully had supported the Administration proposals in the preceding sessions, now made more drastic cuts than the House and applied these most heavily to new program activities. It recommended a budget about $249 million under that of the President, with a reduction of $120 million for the AAP, and with elimination of Voyager and the added Mariner flight for 1971. The committee was not convinced that the "limited additional data" from the Mariner 1971 merited substantial expenditure for it; it felt the Voyager could be deferred in view of the budgetary situation and that NASA should study possibilities for planetary exploration "using smaller, lighter, less sophisticated, and consequently less expensive, spacecraft" than the Saturn V. It looked favorably upon the AAP, with limitation to earth orbital and extended lunar exploration. It felt, however, because of the flight delays occasioned by the 204 fire, that NASA was "overoptomistic" in its AAP flight plans. The committee thought it was recommending sufficient money for preparatory work, continued development of manned space capability, and proper phasing-in of AAP flights with Apollo flights.24/

The favorable report of the House committee was accompanied by some vigorous dissents. Congressman William F. Ryan (Dem., New York) echoed the sentiments that others had expressed at an earlier date: that NASA did not present options to Congress that permitted it to exercise its appropriate role. He wanted many reductions in its requests, and especially wanted no administrative operations funds appropriated until NASA showed how these were allocated to programs. He wanted a contingent allocation to the AAP pending its presentation of five-year costs and comparison with MOL to give "the public . . . a chance to participate in the charting of a clear, rational and efficient course for space exploration."25/

23/
U. S. House, Authorizing Appropriations to the National Aeronautics and Space Administration, Report No. 338, 90th Cong., 1st Sess., p. 30. (Hereafter cited as House Report No. 338.)

24/
U. S. Senate, NASA Authorization for Fiscal Year 1968, Report No. 353, 90th Cong., 1st Sess.

25/
House Report No. 338, pp. 159-65.

Congressman Fulton repeated dissenting comments of the preceding year.[26/] For the AAP he wanted continuation of research and planning without "premature commitment to hardware that may be incapable of performing the missions." He would cut the AAP authorization to $94.7 million, and also cut OMSF's advanced missions budget. He strongly favored development of new propulsion technologies, including the money for NERVA II. "My criticism has been and continues to be that NASA tends to be a large engineering, plumbing, and manufacturing concern with the emphasis on science becoming less and less."[27/]

All Republican members of the House committee except Alphonzo Bell (Rep., California) signed statements favoring larger committee staffing and a minority staff. Dissents on particular programs were filed, and Rumsfeld, with the concurrence of most of his Republican colleagues, wrote in favor of his proposed legislation for an "aerospace Safety Advisory Panel" to obtain greater emphasis in NASA on safety, which, they said, the Apollo fire had shown was needed.

These dissents foretold a battle on the floor of the House. In fact, the discussion in the House on the NASA authorization for FY 1968 is a peak in the deliberations on post-Apollo space activities. Whether or not it was a "great debate" on the issues, it was a time of extended discussion, political maneuver, and multiple votes. Committee chairman George Miller said, after three days of it, "we have had a great fight." The discussion was heavy in content; yet quorum calls on several occasions showed the difficulty of obtaining congressional attention to a floor debate. Miller's general explanation was followed by explanations by the chairmen of subcommittees, and by statements from most senior, and some junior committee members, of both parties, giving general support to the committee report. It had been sent to the House on the favorable vote of all except one member. But the committee members debated with each other, across party lines, on specific parts of the authorization.

Arguments spanned the spectrum. Some were in micropolitical terms. F. Edward Hebert (Dem.) of Louisiana, a state favored by space appropriations, wanted to know, if there were a cut, "how could members explain this to those people who will be out of jobs, or to the owners of those plants that will be shut down."[28/] But Representative Edward J. Gurney (Rep., Florida) noted that "space does not have the appeal in some states as in others."[29/] There were discussions of national benefit. Charles E. Wiggins

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26/ See pages 187-88.

27/ House Report No. 338, pages 166-73.

28/ Congressional Record, June 22, 1967, p. 7788.

29/ Ibid., p. 7807.

(Rep., California) asked, "Why is it necessary for men to set foot on the moon at all?"30/ One answer was from Gurney: Apollo Applications, our space program of the future, is of propaganda value in our race with the Russians. 31/ Another one was from Minnesota Representative Karth: "The word 'space' is just a fancy way of saying research . . . /and/ in so many cases research cannot be traced to a final outcome."32/ Miller referred to Daniel Webster's questions on an appropriation for a railroad across the continent:33/ "What do we want with these wide open spaces, these deserts? What do we want with these mountains, covered with snow to their very bases? What do we want with the vast plains filled with rattlesnakes?" Issues of purpose for NASA were argued. Ryan thought NASA was not properly in the business of pure research,34/ but Fulton and others had an opposite viewpoint. Most of the members were thinking of priorities at a moment in time and of the appropriate allocation for space in its contest against the costs of the Vietnam War and of social welfare programs.

Many amendments were proposed. One by Congressman H. Gross (Rep., Iowa) proposing a $1 billion reduction gained little support. Three by Ryan, an inveterate and vocal opponent of NASA and of high space expenditures from within the space committee, were defeated. Donald Rumsfeld's amendment for a safety council narrowly was defeated. Such was the fate of the majority of amendments.

Fulton was at the center of the major contests from the beginning to the end. Competent on science and technology, highly informed on the technical and policy aspects of the space program, keen and serious, he knew definitely the kind of space program he wanted. It would be science oriented, would emphasize the development of more efficient and advanced space vehicles, and would serve international aims. Initially, he attacked the AAP by proposing a $250 million cut in the authorization for it. Just as Teague had presented a complete and clear analysis of AAP in his argument for the manned space program, Fulton was thorough and vivid in his reasons for opposition. The needs for funding, he argued, were reduced by the slippage of the schedule for the workshop and ATM missions to 1969 and beyond. Fulton believed that the partial funding of seven Saturn IB's beyond the Apollo orders in the 1968 budget could provide as many as twelve S-IB's for AAP, which could be more than was

30/ Ibid., p. 7790.

31/ Ibid., pp. 7806-7.

32/ Ibid., June 27, 1967, pp. 8090-91.

33/ Ibid., p. 8092.

34/ Ibid., June 28, 1967, p. 8190.

needed and also could be obsolete. Viewing the plans for additional Saturn V boosters, he was convinced that the production schedule of two each in 1970 and 1971 followed by restoration of four per year would be more expensive than completing production at six per year. He thought that the possibilities of the Titan-III-M made it unnecessary to produce Saturn IB's in the number proposed, and that little or no funds for payload integration of experiments was needed at the current stage.

Fulton's amendment for a $250 million reduction was lost in the battle over a substitute. On this issue, the leadership was taken from him. In a move that Gross called "wheeling and dealing" and Ryan said was "concocted overnight" to stop the Fulton amendment, Roudebush (Rep., Indiana) proposed a cut of $65 million. While Fulton and Charles Jonas (Rep., North Carolina), ranking minority member of the House appropriations subcommittee that considered NASA appropriations, considered this cut too small, it drew enough support to pass 110 to 82.

Fulton still had another amendment: a recommittal motion instructing the space committee to reduce its schedule of authorizations by another $136.4 million, which would include the trimming of Voyager, NERVA, launch vehicle procurement, university programs, and the elimination of an appropriation for advanced manned missions. He included also Rumsfeld's safety council proposal. His motion passed on a roll call vote 238 to 157. It was not, however, a strictly partisan vote. Four Republican members of the space committee--Mosher of Ohio, Pettis and Bell from California, and Gurney of Florida (the latter two had large space expenditures in their districts)--voted against it; Democratic member Ryan voted for it.

Fulton's action has been the basis of much comment in Congress and NASA. Some of his Democratic colleagues thought that, particularly since the House space committee had accepted a cut in Apollo funds on his suggestion, he should have offered his amendments to the committee; there was some bitterness as a result of his action. Some persons close to the scene have tried to explain his support for new booster development as constituency interest, but others have credited Fulton with ability to reach judgments on the basis of his own scientific analysis. Fulton stated that he--with the help of staff members Hines, Gerardi, Colonel Gould and his young office assistant, Richard E. Beeman--tried to base decisions on technical matters and present the conclusions openly, and that the House had confidence in his ability to report on technical aspects of the space program.35/

An obvious question is why Fulton included in his amendment a cut in NERVA, the most promising program for the new booster development he favored. Beeman explained to the authors that Fulton knew he had to spread the cuts to gain support for his amendment, that he knew that the Senate would take care of NERVA, and that this could be done within the House authorization

35/ Interview with James G. Fulton, July 1968.

limits because the Senate committee had cut the AAP much more deeply than had the House.[36]

Senate deliberation, concluded the same day, was brief.[37] Senator Anderson reported that there were no objections in the committee to any of its recommendations and that the report was unanimous. He alluded to the difficulty of getting attendance at committee hearings; the records show five to nine out of fifteen members attended each, with only Anderson, Holland, and Smith attending all three meetings of the committee. Two proposals for reduction--the first for $316 million, the second for $100 million--were proposed by Senator Proxmire and defeated 50 to 38 and 46 to 38, respectively. He opposed NERVA as a NASA effort to commit Congress to a manned Mars mission. Speaking for the bill or against amendments to it were Anderson, Smith, Holland, Stennis, Mondale, Dodd, Bible and Cannon. The latter two were from a state (Nevada) benefited by NERVA; Cannon particularly spoke of its benefits. Fulbright spoke for Proxmire's second amendment and implied that Holland supported NASA because of benefits to his state. Pastore thought the report was generous to space and hoped Congress would "do as well for the depressed people on earth." The report was approved without a record vote.

The conference committee report reflected the compromises that are customary for such committees. The authorization for AAP, which had been reduced $10 million in the House Committee, $65 million more on the House floor, and $120 million in the Senate Committee, was to be reduced by $107 million. Voyager, which the Senate had deferred and for which the House had voted $50 million, was allotted $42 million, with the stipulation that NASA should make every effort to carry out the 1973 Mars mission as reported to Congress (i.e., with an orbiter and a landing craft). But the Mariner Mars 1971 mission was dropped, as the Senate had favored. NERVA, as Fulton anticipated, was taken care of: it came out with only a $1 million reduction below the President's and the Senate's figure. House support for the 260" motor was accepted to the level of $3 million, with the bill to specify that the money be used for this purpose. In sum, all programs except Mariner Mars 1971 survived but extension of manned space exploration through AAP and of planetary exploration through Voyager would be curtailed. Likewise, several other programs were reduced, although the Apollo program came out with only a $10 million cut from the President's recommendation of $2,546.5 million.

36/ Interview with Richard E. Beeman, July 30, 1968.

37/ Congressional Record, June 27, 1967, pages 9012-17; June 28, 1967, pp. 9078-93.

The conference committee report became the authorization, as signed by the President on August 21. The reductions from the President's recommendations totaled $234 million. By August the pressure of domestic and military events was increasingly engrossing the attention of Congress. Riots in the cities had begun with Newark and Detroit in July; but the immediate budgeting pressure was from the mounting costs of the Vietnam war. The figures for new programs had become meaningless: Congress now was trying to avoid a $29 billion deficit and had before it the President's recommendation for a surcharge of 10 percent on the income tax. In this situation the House appropriations subcommittee called for additional hearings on the space appropriations,38/ which provided an opportunity to meticulously question NASA officials on specific expenditure items. Webb himself noted the atmosphere that prevailed:

> The President has reviewed with me personally the "blackboard exercise," and his concern about the deficit that is indicated at $29 or $30 billion, his concern about the borrowing capacity of the Nation, his concern about the necessity to reduce expenditures at the same time he is making an urgent request for tax increases, and he is asking me to do everything in my power to help him with these programs.39/

He asked the committee, however, to "support the full funding of the authorization."40/ He explained how the amount of $347 million authorized for AAP would be used: $23 million for definition of experiments, $80 million for development and test of modified spacecraft, $69 million for the orbital workshop, $55 million for the Apollo telescope mount, $35 million for payload integration and mission support, $62 million for the purchase in 1968 of four follow-on Saturn IB's, and $20 million for long lead-time items for two follow-on Saturn V's. As Mueller explained the follow-on Saturn purchases (i.e., beyond the 12 Saturn IB's and 15 Saturn V's in the Apollo program), the Saturn IB purchases would keep the production line going at the Chrysler portion of the Michoud plant, and the $20 million would buy forgings, aluminum rolled stock, etc. Fulton appeared before the committee to support Voyager and NERVA and to attack NASA on Saturn production. He proposed, nevertheless, only a $13 million cut from the Saturn IB purchases and that NASA be cautioned to look carefully at Saturn V lead-time purchasing. Teague filed an answer to Fulton.

38/ U. S. House, Committee on Appropriations, Subcommittee on Independent Offices, Hearings, National Aeronautics and Space Administration Appropriations for 1968, 90th Cong., 1st Sess., August 15, 1967.

39/ Ibid., p. 35.

40/ Ibid., p. 8.

The Senate appropriations subcommittee had held its hearings about three weeks earlier.[41] The authorization bill was still before the conference committee and Senator Holland, thinking of how the differences would be compromised and interested in the maintenance of Apollo operations, expressed "amazement" that Webb would not set priorities among programs recommended. "Senator Holland," Webb replied, "I don't want to give any aid and comfort to anyone to cut out a program."[42]

Following usual practice the House Committee on Appropriations reported first. It recommended a $516.6 million reduction from the President's recommendation--over $282 million below the authorization, and $384.6 million below the FY 1967 appropriation. This, said the committee, was "less than would be recommended under less stringent fiscal circumstances," but would, in its opinion, "support a viable space program." Although the appropriation bill would not specify these items of expenditure, the committee report showed that it had arrived at its result by cutting out Voyager and by reducing AAP $47.7 million more to $300 million and other programs by lesser amounts.

This report was the watershed for the space program being planned by NASA. Impelled by the desire to capitalize on its developed technology and by the realization that a long-range program, such as a manned mission to Mars or a large space station, could not be initiated in a period of budget stringency, it gradually had evolved an "intermediary" incremental manned space program of continuing production of modified Apollo hardware and of earth orbiting and lunar missions for use of such hardware. Impelled also by the desire to carry forward a planetary program, it had proposed the Voyager. Finally, desiring to build for longer range objectives, it had joined AEC in support of NERVA and had carried forward smaller programs, such as the SNAP-8. These programs had been recommended by the President. Supporters of the space program in House and Senate space committees had differed over the balances between these programs and reluctantly had accepted the necessity of debating priorities in funding cuts. Now the House Appropriations Committee had cut deeply into the funding and NASA would be forced to replan with reduced objectives. As for AAP, the slide downward in its plans, which began in BOB considerations, would continue.

41/ U. S. Senate, National Aeronautics and Space Administration Appropriations, Hearings on H.R. 12474, 90th Cong., 1st Sess., July 26, 1967.

42/ Ibid., pp. 75-83.

NASA's only immediate hope for effective support was dashed when the President announced three days later, while signing the authorization bill on August 21, that he would not oppose the Appropriations Committee's reductions. He noted that

> . . . conditions have greatly changed since I submitted my January budget request. . . . /This action does not/ indicate that we have lessened our resolve to maintain a strong program of space exploration, science and technology. . . . Because the times have placed more urgent demands upon our resources, we must now moderate our efforts in certain space projects. But our purpose still remains as constant as the heavens we seek to explore: to master the challenge of space.

On the following day the House approved the recommendations of the NASA appropriations subcommittee. Joe Evins (Dem., Tennessee), the chairman of this subcommittee, noted that programs could "be deferred;" Jonas, the ranking minority member, believed a streamlined NASA could be a more efficient NASA, and called the lunar landing decision of 1961 a mistake. Gross attacked Webb and NASA's administration, while Ryan proposed an amendment for a $37 million cut in the AO item. Fulton defended his favored programs; Teague defended the authorization figure. Some, such as Nevada's Baring with respect to NERVA, protested particular cuts.

The Senate Appropriations Committee, reporting later, supported a figure $95.5 million above the House bill. Its report was approved in the Senate, after defeat of a Proxmire amendment for further reduction. A conference committee was unable to resolve the major differences between the houses. Each house supported its conference managers, and a second compromise attempt followed in the conference committee. The Senate conferees now were supporting Voyager, with the House conferees opposing it; this was a reversal of the situation that had existed when House and Senate space committees reported. The Senate conferees also wanted a higher figure for NERVA and for facilities construction for it in Nevada; the House wanted $15.5 million more for AAP. In the end the houses approved a figure only $5.5 million above the initial House action, which the President had said he would not oppose. The final conference committee reported that it was its understanding that Webb would come back to the space and appropriations committees of Congress with a reprogramming within the total appropriation.

The conference committee had in mind the flexibility in use of funds allowed to the Administration but subject to report and possible disapproval by congressional committees.43/ In view of this flexibility the most vital factor for the Administrator was the total sum of the appropriation. He would need to be cognizant, however, of the decisions on items in the authorization and appropriation acts, of the compromises these

43/ See Chapter III.

represented, and of the strength of the various motivations that led to the decisions--even of the strategic position of some members of Congress who had favored or opposed levels of expenditure for line items. He would be cognizant of nuances of opinion that did not appear in the written records of Congress. At the same time, he would need to reevaluate within his organization the status of on-going projects and the sums needed to support without impairment priority programs, to sustain progress on preferred projects, and to keep alive opportunities for future project development.

The operating plan for FY 1968 was completed on November 6, over four months after the fiscal year had begun. It was presented in executive session to both space committees and thereafter explained by letter to the chairmen of the appropriations committees. Little formal reprogramming was necessary. On the intermediary programs $1 million was allocated for completion of a Phase B study on Voyager and $253.2 million was allocated to AAP. Long-range developments suffered also: work on the NERVA I flight-qualified engine would continue, but it would be impossible to proceed with the NERVA II 200,000-pound-thrust engine. As the House space committee always had desired, the 260" large solid motor was continued on the limited scale that would keep options open; but there was no allocation for advanced missions studies in OMSF. Webb reported to the Senate space committee that limited teams could be kept together on Voyager and NERVA until further decisions could be made, and the options kept open on the 260" motor until it could be decided whether a 100,000-pound-payload rocket was needed.

Retrenchment and Deferral: Mid-1967 to Mid-1968

As budget cuts were made or anticipated, numerous NASA officials at several levels of organization were engaged constantly in replanning programs within budget limits. This was especially true of the AAP office, which spent most of its time revising schedules and program content. It was said that at one time seventy plans were drafted within a couple of months, but officially the office was committed to different plans in May, November, and December 1967, January and June 1968. The successive plans all retained a common core of missions but with a progressive trimming of missions and slippage of schedules. The environment of decisions was political, not technical; the manpower of the space program was engrossed in the adaptation of the program to the winds of change in annual budget reviews at numerous, successive centers during the same period when the agency, through massive effort, was attempting to recover physically and psychologically from the stunning setback caused in its largest program by the Apollo 204 fire. A "rolling adjustment" (Webb's phrase) was under way.

Webb now became more involved personally in the coordination of NASA programming. A background statement in the BOB's files on the FY 1969 budget notes that he had taken charge of the preparation of the 1968 operating plan and the 1969 budget, and that in some cases he had drafted budget summaries. A comment to Fulton in the FY 1969 authorization hearings indicated that Webb personally had prepared replies to questions submitted by Fulton.44/ Within NASA, contracts for AAP hardware in late 1967 and in 1968 were being delayed or renewed for short periods; Webb personally made decisions on these, and acted virtually as a program manager for the AAP insofar as these hardware contracts were concerned. Charles W. Mathews, director of the AAP office, was regularly in direct communication with Webb; when Harold T. Luskin, an industry executive, was installed as head of the AAP office in May 1968, he was told by Webb to report directly to him as need arose.

Combined with budget stringency were other factors that influenced decisions in this period. At this time there had been no manned flight test of the LM (an event that would occur in October 1968). The delay in flight of the complete Apollo spacecraft occasioned by the 204 fire was a restraint on AAP. Webb did not want any interference with the Apollo schedule. He had given instructions that no hardware modifications of Apollo for the AAP should be made without General Phillips' certification that there would be no impairment of the Apollo plans. When needed he used funds from other sources to stay on the Apollo schedule. He was given permission by the Budget Bureau to operate under the assumption that he would have $253.2 million for the AAP, but he transferred a portion of this to Apollo during FY 1968.

One evidence of Webb's caution and his balance of Apollo and AAP objectives was shown in a four-page memo to Mueller on January 8, 1968, in which he reviewed his position on contracts with North American Rockwell (NR) for Apollo CSM modifications to meet AAP requirements. Approval was being given at that time to renewal of NR's contract for modifications to February 15. Webb wrote that he had great doubts after the 204 fire whether NR had the capability to build a spacecraft that NASA would accept as flightworthy. To establish an environment for NR's success, NASA encouraged the company to focus attention on the standard CSM configuration (that required for Apollo). This would prevent the diversion of its resources to other CSM-related business. Also, NASA informed Congress and industry that the agency would not contract with NR for CSM modifications while it was endeavoring to overcome the problems brought to light by the fire. While NR had made progress, the Apollo spacecraft still had not been flown, and the alternative of using another contractor or contractors still was open.

44/ U. S. House, Committee on Science and Astronautics, Hearings, 1969 NASA Authorization, 90th Cong., 2nd Sess., Part I, p. 101. (Hereafter cited as House Space Committee, FY 1969 NASA Hearings.)

Both environmental and internal conditions forced tight correlation, balance, and choices in program plans. These also pushed Webb into a position where he had to make the decisions. The 204 fire had shaken his confidence that all was well within the organization. His deputy (Dryden) had died, and the resignation of his general manager (Seamans) became effective January 5, 1968. Moreover, he now was taking steps to achieve an agency-wide view and to counteract bureau independence within the agency. Newell from OSSA succeeded Seamans and was given instructions to develop planning processes on an agency-wide basis. First, Edgar M. Cortright, Newell's deputy in OSSA, then Charles J. Donlan of Langley Research Center, became Mueller's deputy; George H. Hage, OSSA's "chief engineer," was transferred to Apollo. All lunar exploration planning, previously divided between OSSA and OMSF, was placed in a Lunar Exploration Office, with its director reporting to the heads of OSSA and OMSF on aspects of lunar exploration related to their respective responsibilities. Finger, named as Associate Administrator for Organization and Management in the revision of top management structure in early 1967, had an agency-wide responsibility for planning, coordination, and control.

Although the AAP had been accepted in the agency as its new manned space flight program and had been approved by the President, it was not a fixed program and was subject to frequent reexamination. An illustration of this and of the efforts to obtain agency-wide consideration was shown in Webb's request in late August 1967 to Dr. Mac C. Adams, Associate Administrator for OART, to review the AAP program. Adams had said in a conference in Webb's office that he, as a senior officer in NASA, could not support the AAP. Seamans said he would make a further study on the points raised in the discussion. Webb, however, abandoned the usual channels and asked Adams to prepare materials and report to top management. The report was presented to Webb and other officials on October 14. Adams and his associates began with broad inquiries: "Can MOL do the NASA job? Is the spent S-IVB workshop a reasonable concept? Is the S-IB vehicle essential to NASA and the nation?" Adams' comments, however, stressed concern over the plans to fly a 28-day workshop mission and to follow it a few months later with an expensive 56 ATM mission; he suggested a follow-up 56 workshop mission prior to the ATM mission. Adams also was concerned about projections for synchronous earth orbits somewhere down the line without definition of payloads and payoffs in scientific knowledge.

The delays, deferrals, and uncertainties on the AAP were constraints on the OMSF and on Mueller as its administrator. A memo on September 14, 1967 from Webb to William E. Lilly, NASA's budget officer, noted that, as he had reported to Seamans and Newell, he had had a "very frank, full talk" with Mueller. Mueller had accepted the plans on funding and scheduling, but with hope that some earlier scheduling would be possible and that he would have opportunities to present reasons therefor at an appropriate time. Mueller understood, Webb said, that the agency would have "a good deal of fluxing debate".

The "fluxing debate" was to take the form of a new review and search for consensus in the first half of 1968. Dr. Floyd L. Thompson, who was retiring from the post of director of the Langley Research Center and who had directed NASA's study of the Apollo fire, was designated by Webb on January 6, 1968 as Special Assistant to the Administrator with the specific responsibility of serving "as chairman of an interim working group on manned operations established to evaluate future manned flight projects." It was to be a blue ribbon group; Webb suggested including, among others, the heads of NASA's headquarters offices and of OMSF's centers. Thompson was directed to identify alternate goals and alternative projects and to compare these. The Thompson group met once in Washington and once in each of the three OMSF centers and Thompson sent a report to Webb on July 20, 1968. Thompson noted that the report would be important as support for the Associate Administrator's (Newell's) planning activity, and Webb, in his acceptance letter, saw it as important to the development of the 1969 operating plan.

While the report will be discussed later, the formation of the Thompson committee shows the uncertainties within the agency about the AAP program at the beginning of 1968. It is impossible to pinpoint any firm program for any date.[45] Nevertheless, the revised manned space flight plans as they existed about the end of 1967 can be gathered from the operating plans for FY 1968, from the FY 1969 budget submittal to the Budget Bureau, and from NASA presentations to Congress early in 1968. At this time, the manned space program included several phases.

1. The Apollo mission, still having an allocation of over half NASA's budget, had top priority, and there was hope for the first lunar landing in the last quarter of 1969.

2. Follow-on visits to the lunar surface at the rate of two each year, beginning in 1971 and extending through a period of years, was planned. Funding of studies for continued lunar exploration was from the AAP allocation.

3. The earth orbital missions of AAP had slipped since the FY 1968 budget was prepared from 1968 to 1970, and would follow rather than parallel Apollo flights prior to and including the first lunar landing. Funding in FY 1969 was asked for four AAP missions on six Saturn IB launches:

45/ For example, ML-13A, set forth for planning purposes only and not as an approved project, was described in the Administrator's Status Review of AAP on January 11, 1968. It did not correspond exactly with the program outlined below, for among other things it followed the dropping of the AAP-IA mission included below.

a. An AAP-IA space science mission of up to 14 days, carrying a crew of 3 on the CSM and a payload of experiments on the LM. It had been added in the first half of 1967 and was to be primarily an earth applications flight, with earth and weather photography included in the experiments.

b. The workshop mission (the first "cluster") involving a dual launch (AAP 1 and 2) and rendezvous of the CSM-LM and the Saturn IVB spent stage. The mission would extend to 28 days and was planned for 1970. There would be a resupply and revisit mission in 1971 with astronaut time in space of 56 days.

c. A solar observatory mission (ATM), a dual launch of a CSM and the ATM to revisit and reuse the workshop for solar observation. It also would be a 56-day mission and was scheduled for 1971.

d. Three follow-on revisits in 1971 to the workshop from new launches of the CSM-LM with anticipated stay time of 56 days and with a 6-month duration for one crew man.

Cancelled from the preceding year's plans were a second Saturn I workshop and revisits to it, and a second ATM to be flown in conjunction with the second workshop. NASA's November 16 staff analysis for the budget submittal noted that a second workshop cluster was not possible before late 1971 or 1972 and added words that could be construed as evidence of excessive funding requests in the past: "There appears to be little merit in planning on two essentially identical clusters." Similarly, no funding was asked for a synchronous orbit mission, the staff analysis said, "because the basic objectives of such a mission are yet undefined."

4. Continued production, after the twelve Saturn IB's and fifteen Saturn V's in the Apollo program, at the rate of two each per year. This contrasted with a planned rate of four each in the FY 1968 budget and six each in NASA's initial Apollo Extensions planning. The beginning of deliveries on the post-Apollo Saturns was anticipated as 1970 for the IB's and 1971 for the V's. Lead items were to be purchased in FY 1969 on four Saturn IB's (numbers 13 to 16) and two Saturn V's (numbers 16 and 17). At this time it was anticipated that six Saturn IB's and four V's would be surplus from the Apollo program.46/

46/ See House Space Committee, FY 1969 NASA Hearings, Part I, p. 160.

Webb was not ready to give up the possibility of increasing the production to four per year of each type of vehicle. A memo for the record of January 17, 1968 summarized a conference of Webb and other NASA officials in which he asked for a study of ways to maintain production at two each per year while maintaining capacity to expand to four each per year. He suggested the policy should be, "So plan our production to maintain our facilities as to have the capacity for original production plans, not closing down any installations (MTF, Michoud, KSC, MSFC) in order to retain this original capacity."

CSM's developed for the Apollo program were to be modified for AAP use, and modifications of the LM were to be designed and long-lead procurement of hardware initiated in FY 1969.

5. Accepted was the idea of a Saturn V space station--a manned, dry space station launched by a Saturn V sometime after 1975. " . . . a long duration space station is the keystone in the future of Manned Space Flight," said Mueller;47/ according to Webb, the Saturn IVB was "considered as an interim step toward the Saturn V workshop."48/

6. Development of new rocket capability was now dependent upon two projects:

   a. The NERVA project. Over a billion dollars had been spent on a nuclear rocket program by AEC and NASA. Plans for the NERVA II, a 200,000-pound-thrust rocket that, by serving as a third stage, approximately could double the power of the Saturn V, was abandoned because of budget cuts; development would proceed on the NERVA I engine, which would have 75,000 pounds of thrust and would be equally effective for many missions, but not for manned planetary flights. This added potential to the capability of the Saturn V could be sufficient for manned planetary exploration in 1986 but would be insufficient for more demanding years.49/

47/ Ibid., p. 121.

48/ Ibid., p. 5.

49/ See on this point, ibid., Part IV, pp. 325-26. For further information see Part III on "Nuclear Rockets Program" of U. S. Senate, Committee on Aeronautical and Space Sciences, Hearings, NASA Authorization for Fiscal Year 1969, 90th Cong., 2nd Sess. (Hereafter cited as Senate Space Committee, FY 1969 NASA Hearings.)

b. The 260" motor. The team working on this was being held together and the options for further development held open pending the result of discussions with the DOD on the need for an intermediate size rocket between the Saturn IB or Titan III and the Saturn V.50/

NASA also was planning at the beginning of 1968 for continuation of unmanned planetary exploration. Substituting for the Voyager program were plans for two Mars missions each in 1971 and 1973 (to follow the two planned for 1969) on the less costly Mariner spacecraft. Also planned were flights by Venus of two spacecraft in 1973.

Curtailments in the AAP plans occurred almost as soon as they seemed to be fixed. The AAP-IA mission was cancelled in January 1968. In spite of touted benefits from an earth resources survey, this late entry in AAP had lower priority than the S-IVB workshop and the ATM and hence was vulnerable in a period of budget stringency. There was some concern that other agencies would not be ready to participate effectively in an early flight, and that international complications such as existed in other programs where cameras were focused on foreign countries would be aggravated in the IA mission; there was also realization that substantial progress in earth resources survey could be made from unmanned flights. Nevertheless, these considerations had been present when the IA mission was added to the AAP, and its cancellation was determined solely on budget considerations.

By January also CSM production plans had been modified greatly. While the FY 1969 budget plan prepared in May 1967 had contemplated follow-on production of eleven CSM's, by January 1968 the planning included no follow-on production and modification of only six of the Apollo group. By June there was discussion of cutting off all Saturn production at the end of the Apollo schedule and of storing parts already produced on Saturn IB's 213 to 216. A definitive contract on the Airlock also was being held up. The AAP now was operating on a stretchout that assumed use of the $253.2 million of the 1968 funding over an 18-month period extending halfway into FY 1969. Webb in a memorandum to Finger on June 28 referred to an agreement with Congress and the budget director that commitment of funds would not be made until "we had a sufficient degree of certainty to be sure we were going forward with the AAP in some consistent and cohesive form." The memo contained a reference to lack of payloads for all the S-IVB's that would go into storage if Saturn production were stopped--an admission at that late day of a gap between mission planning in NASA and production

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See particularly the discussion in House Space Committee, FY 1969 NASA Hearings, Part IV, pp. 198 ff.

scheduling. The memorandum referred to conversations with DOD on ways to proceed in view of budget reductions for both DOD and NASA. A memo from Webb to Mueller on January 8 had noted that "current discussions with the Department of Defense may turn up a number of alternatives to the use of Apollo equipment in the accomplishment of the nation's total space program."

The Fiscal Year 1969 Budget

There was little that was new or distinctive in the rerun of the NASA budget for FY 1969. Webb called it a budget of retrenchment and deferral. The same kinds of programs were considered as in 1968, the actors were the same, Apollo support was maintained, and the trimming of post-Apollo activities was continued.

Webb opened congressional presentations with a statement that the Administration's budget was $730 million less than that presented the year before, and $219 million below that appropriated. NASA was met repeatedly with requests for explanations of the benefits to society from tax dollars for space--usually from those who themselves were favorable to or even enthusiastic about space exploration. The appeal was made at the beginning of Senate hearings by Senators Anderson and Smith; it was pressed by Senator Holland and Congressmen Gurney and Daddario.51/ Answers, on the whole, were fragmentary. The scientists had conferred extensively with NASA on a substitute program for Voyager, and statements were made or submitted by leading scientists on the benefits of the planetary program now planned by NASA.52/ Oran Nicks of NASA presented to the Senate a carefully prepared and comprehensive rationale for exploring the planets.53/ But other responses were as fragmentary as that of Von Braun who, in response to the pleading of Daddario, referred to the economic benefit of new management techniques and the appeal to "a kid" to become an engineer.54/ There was at times

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51/ See especially ibid., Part II, pp. 165-66, and 247-49, and Senate Space Committee, FY 1969 NASA Hearings, Part I, pp. 2, 7-8.

52/ House Space Committee, FY 1969 NASA Hearings, Part III, pp. 159 ff., and Senate Space Committee, FY 1969 NASA Hearings, Part II, pp. 781 ff.

53/ Senate Space Committee, FY 1969 NASA Hearings, Part I, pp. 361-64.

54/ House Space Committee, FY 1969 NASA Hearings, Part II, pp. 248-49.

reference to the contest with the Russians, the theme Webb had emphasized repeatedly in past presentations. Not until Teague made a comprehensive statement in discussion on the House floor on the authorization bill was there a serious effort to respond to the kinds of questions Americans were asking of congressmen about expenditure of their tax dollars for space exploration.

Even for the curtailed AAP, NASA and the Administration were asking for $439.6 million--a sum far below what would have been requested if the 1968 program had been approved, but highly unrealistic, politically, by the time Congress was making its FY 1969 decisions. It included $201.3 million for space vehicles, $190.3 million for experiments, and $48 million for mission support. The latter included $31 million for payload integration and $17 million for launch-related activity. The experiments sum included $25 million for definition, $30 million for the Saturn I workshop, $32 million for the ATM, $50.3 million for a Saturn V workshop, and $53 million for experiment payloads. These sums were presented as gross figures without breakdowns; explanation was lacking on how the Saturn V workshop funds would be expended, or on how they differed from $5 million asked for Advanced Missions, principally for study of a permanent space station for the mid-1970's. Yet the only penetrating questions on these matters in committee meetings related to the sums for space vehicle procurement. Of that $201.3 million, $104.6 million was for spacecraft modification, $61.3 million for Saturn V procurement (with initial production on the first two post-Apollo vehicles, Nos. 516 and 517), and $35.4 million for Saturn IB procurement (continued production of Nos. 213 and 214, and long-lead procurement on Nos. 215 and 216). Fulton wanted to know whether there would be a surplus of IB's. Mueller explained that a surplus of six was expected from the Apollo program. The "core" program outlined on pages 211-12 as items 3(b) and (c) (workshop missions, ATM mission) would use five IB's and the follow-up missions three more. This, it was clear, wouldn't satisfy Fulton: (1) because the latter three missions were problematic, and (2) because he saw NASA having a surplus of seven, producing two more (213 and 214), and buying long-lead on another two (215 and 216), thus making a total of eleven. Mueller, on the other hand, received strong support from Daddario, who, with Mueller's concurrence, saw it as a question of whether NASA was "to go out of business." He thought the production schedule was down to the minimum, and was "fearful" that the impression that the IB's were not needed would exist in the debate on the House floor.55/

55/ See for this budget discussion, ibid., pp. 90-95 and 147-210.

These discussions reflected old divisions. NASA and its supporters in the manned space subcommittee wanted to maintain productive capability on Saturn vehicles and to find missions that would make use of this capacity. Fulton was willing to develop new productive capabilities (as through NERVA) without missions being defined for the new capacity, but he was not willing to continue production of Saturn vehicles beyond stated and accepted mission requirements. While this issue was focused, other items in the AAP budget received very limited attention in the hearings although they were voluminous in technical explanation unaccompanied by cost analyses.

The capability-missions conflict was portrayed also in the discussion of the NERVA I engine. Webb preferred the larger NERVA II, with its 200,000-pound thrust in comparison with NERVA I's 75,000; but with limited funding he favored the latter to "develop a capability that may be essential to our future as a nation." Some members of Congress had thought that NASA was trying to build capacity for a specific mission--to send a man to Mars. Webb stated "categorically that we do not have such a plan. . . .this was not the basis of our request for NERVA I, and was not the basis of our request for NERVA II last year." Webb saw as a specific mission for the NERVA I to "resupply missions to a synchronous or polar orbit," which an agency expert said could be done by substitution of the NERVA engine for the S-IVB as a third stage on the Saturn V. It also might have advantages in lunar exploration. But Webb was thinking of "the state of the art," of avoiding "a crash program of some kind in the future" because of USSR capability, of "a central focus for a continuing advance in the nuclear and other technologies involved."56/

This capability orientation differed from the mission orientation reflected in Senator Proxmire's proposal in Senate floor consideration to reduce the authorization for NERVA. Proxmire saw "no approved mission at this time" for NERVA; he thought the only mission for it could be a manned planetary landing, for which Congress was not ready to make a commitment. Anderson denied that this was "necessarily" the only mission for NERVA. The real conflict was capability plus mission indeterminateness versus mission definition plus capability for mission performance.

The consensus that Webb desired was still absent. There was strong bipartisan support for a space program in the Senate, with

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56/ For Webb's discussion on NERVA, see Senate Space Committee, FY 1969 NASA Hearings, Part III, pp. 814-28.

Senator Smith supporting the program as vigorously as NASA's Democratic friends; but there were also strong attacks. In the House, the Republican leadership marshaled an attack on the space committee's proposals. Cuts were made in authorizations in both the House and the Senate, and even after cuts there were 105 House members and 4 Senators who recorded their votes against the NASA authorization. While facades of unity were maintained--unanimity in Senate space committee reports and unanimity, except for Ryan, in positions of House Democratic space committee members--there were differences to be compromised in the committees and between the houses; there were differences also, virtually identical with those of previous years, set forth in the additional comments of Ryan and Republican members in the House space committee report. Whatever explanations their foes or associates might give for the positions taken by these men, their comments reflected the issues on which there was division. Ryan attacked the rationality of the lunar landing decision, proposed practical and scientific payoffs as tests of the space program, and argued for a choice between unmanned and manned space programs. Fulton supported manned space activity but attacked AAP, and supported new booster technologies but was opposed on NERVA by several of his Republican colleagues; he also favored transfer of MOL to NASA. Wydler believed that AAP should be part of a "larger unified program" conducted by the DOD; Rumsfeld lamented but saw the necessity for deferment of NASA goals because of higher priorities.

It was the last of these that was decisive in consideration of the FY 1969 budget. While NASA's authorization was before the houses, committees were considering the big fiscal action of the year: the combination of a 10 percent tax surcharge with a requirement for a $6 billion appropriation cut. This tax-increase, appropriations-reduction mood determined the fate of NASA's budget. The totals and sections of this budget were cut at various stages of congressional consideration. The nuclear rocket program was reduced from the recommended $60 million to $11.7 million in the House space committee. The committee also cut $44 million from the recommended $439.6 million for AAP. Fulton then obtained a resolution from the Republican Policy Committee for two cuts, both of which were accepted on the House floor without recorded votes. One, proposed by him, cut AAP to $253.2 million; the other, by Roudebush, reduced the administrative operations budget by $43.5 million.

The Senate committee made a much smaller cut for AAP to allow its continuation with revisions. On the Senate floor Proxmire offered an amendment to reduce the total authorization to $3,370,400,000--$1 billion below the President's recommendation and $780 million below the Senate space committee's recommendation; he said that the reason was not simply a matter of money, but of the excessive use of manpower resources by NASA. He thought NASA was trying to commit Congress to manned missions to planets, and wanted the alternative manned and unmanned budgets Ryan had favored. Proxmire termed his proposed cuts a "modest suggestion" and said, "if I had my way, it would be substantially bigger than that." This meat-ax proposal was rejected by the narrow margin of 38 to 33. Proxmire then proposed an amendment that on several items, including NERVA and AAP, took the lowest figure from House and Senate space committee recommendations. He accepted a compromise on NERVA of $33 million (between the $11.7 million of the House committee and the $55 million of the Senate committee). After strong appeals to the Senate (by Smith, Anderson, and Percy) not to approve the amendment, the Senate accepted it by a vote of 44 to 25. The Senate authorization figure now stood at $4.150+ billion, the House figure was approximately $119 million less, and the final appropriation was $4.008+ billion. NASA now had been brought down from peak expenditures of close to $6 billion to a $4 billion figure.

The 1969 Operating Plan

It was now time for NASA to finalize an operating plan incorporating the adjustments made by it within the total amount appropriated, and to report the adjustments to the space committees. The bill to direct the President to reduce government expenditures 10 percent below the amounts appropriated, with certain specified exemptions, had been passed. Based on conversations with the Budget Bureau, NASA assumed that after its portion of this reduction had been made by the President, and with use of carry-over funds from the previous year, its new obligational authority would be limited to $3.85 billion.

On the eve of the initiation of discussion of an operating plan within NASA, the Thompson Report, referred to earlier, was presented to Webb (July 20, 1968). It was transmitted to the Associate Administrators by the Deputy Administrator on July 28, 1968 as part of the attachments to a statement of the key issues to be discussed in development of the operating plan. The report expressed several concerns about the ATM mission in AAP plans, including the complexity of the rendezvous and docking maneuver required to join the ATM to the cluster, the excessive use of EVA in ATM experiments, the improbability of meeting the objectives of the biomedical program, the absence of back-up hardware in the event of mission failure, and the questionable nature of the ATM experiment when so severely time-limited by its relation to the cycle of solar flare activity. Thus, the ATM mission, a major element in the AAP but questioned at the beginning by the scientists in PSAC, now was challenged within NASA.

The seriousness of the challenge was indicated in the statement of July 28, which set forth key issues to be considered. Among these was the question of whether "in light of reduced NASA funding" the ATM should be continued, deferred to a later operational date, or terminated. The ATM mission was debated vigorously and with uncertain result in a long session--part of day-long and late-night deliberations on the operating plan extending over several days in August--and finally was retained.

Development of the operating plan brought together the top officials of NASA, from headquarters and field, in serious deliberation on critical issues. The Newell planning groups made reports, FY 1970 budget considerations were brought into discussion, and the deliberations were focused on key issues. In the end Apollo Applications was reduced from the authorized amount of $253.2 million to $150 million, which sharply contrasted with the $439.6 million recommended by the President when the FY 1969 budget was submitted. Saturn V production would be terminated with production of the fifteen scheduled from the beginning in the Apollo program, and Saturn IB production would be terminated upon completion of the fourteenth vehicle, two more than had been included in the Apollo program. The mission plans in AAP were summarized in Senate hearings as follows:57/

> In the revised Apollo application program, we will work toward launching, in the early 1970's, a single Saturn I workshop and a single Apollo telescope mount (ATM) of the types we have discussed in the past. A backup unit for each will be prepared. There will be one revisit to the workshop before the ATM is joined to it.

The flight schedule in the drastically reduced AAP program is shown as Figure XVI, page 221.

On some other items related to future manned space flight, NASA reported that: "Later /after the AAP flights/, we hope to proceed with the Saturn V workshop; but work toward that goal under this operating plan will be limited to studies."58/ It also reported that it would transfer to NERVA $7 million to supplement the $32.5 million allotted in the authorization act. Hopes for two lunar missions per year after the initial landing were stated in deliberations on the operating plan within NASA.

A period in space history was coming to an end. Soon the Apollo moon-landing mission would be gloriously successful before the eyes of people around the globe. But Webb would retire before that, in 1969,

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57/ U. S. Senate, Committee on Aeronautical and Space Sciences, Hearing, NASA's Proposed Operating Plan for Fiscal Year 1969, 90th Cong., 2nd Sess., October 3, 1968, p. 8.

58/ Ibid.

FIGURE XVI

APOLLO APPLICATIONS SCHEDULE

	1970	1971	1972	1973
28-Day Mission: Saturn I Workshop Activation and Operations; Medical, Science and Technology Experiments		△ CSM △ SAT I WORK-SHOP	△ CSM △ BACKUP SATURN I WORKSHOP	
56-Day Mission: Revisit and Reuse Saturn I Workshop; Medical, Science and Technology Experiments			△ CSM	
56-Day Mission: Solar Astronomy (ATM); Revisit and Reuse Saturn I Workshop			△ CSM △ ATM	

Source: Memorandum, "Extension of Manned Space Flight Program," September 3, 1968 (MTD).

a new administration would be elected in November, and the manned space program of the future was on dead center. Webb noted to the Senate committee that President Johnson, in his budget message in 1965, had used the words "maintaining world leadership in space," but, quoting from the President's words in later speeches, concluded that "we have had a shift from the stated objective of world leadership and preeminence to the use in these times of the capabilities we have developed."59/ The use itself was small.

Concluding Comments

The AAP's emphasis has been capability; scientific return and social benefit were indeterminate and supplementary. The aim was the test of human capability for flight activity and retention and extension of the capabilities of the Saturn/Apollo hardware. For the latter purpose six Saturn IB's and six Saturn V's were to be produced each year and incremental engineering adaptions made in spacecraft, first, in modifications of the CSM/LM and later of the S-IVB also. This, along with continued lunar exploration, was the intermediary manned space program.

The program drew a weak political response. In part, this was due to deficiencies in administrative development of the program. There was an initial indefiniteness about program objectives. There was an imbalance between, on the one hand, the 6-6-10 formula for hardware production and, on the other, mission and experiment planning. There was room for suspicion in Congress that the production schedule for Saturn vehicles, with its great expense, was excessive in terms of launch capabilities or of missions to fly on these vehicles. These administrative deficiencies led to ineffectiveness in communication with Congress. Between the generality of Webb's short presentations and the detail in Mueller's lengthy and repetitive technical descriptions, there was impreciseness on program and cost in the first presentations to Congress.

One major difficulty was the inability of the agency at this stage in its history to clarify its position on the respective roles of manned and unmanned flight. It offered in Voyager an unmanned program and in AAP a manned program, but there was some opinion among scientists that the manned program was overemphasized, and within Congress that the unmanned program was "a nose in the tent" for a large and expensive manned planetary program.

59/ *Ibid.*, p. 23.

There was in the intermediary, incremental manned space program no large vision and goal that could excite the attention and imagination of the public and Congress similar to the lunar landing objective of 1961. Some congressmen toyed with the idea of a manned Mars landing, but the Administration did not offer it. Within the agency there was continuous talk, and also studies, on a space station, but no progress beyond the study stage and no request for a political commitment to it.

Clientele support to compensate for the lack of an appealing public goal was never present in a united and strong way. Some of those members of the science community who had followed the work of NASA with professional interest could not see in the AAP the possibilities for scientific knowledge that they saw in unmanned ventures. There were no immediate large payoffs in economic benefits to attract the support of industry. The IA mission, added late and then dropped, offered promise only of distant benefits. The only strong clientele support was from those who benefited from NASA contracts, concentrated enough to generate loyal congressional support from a minority in Congress, but insufficient to hold congressmen from areas not heavily benefited. Even in contractor interests and support the conflicts over program objectives were reflected.

It is possible--indeed we would say probable--that the AAP, after being squeezed into acceptable dimensions by NASA's top leadership, the Bureau of the Budget, and the congressional budget process, would have been given adequate support if it had not run into competition with other demands on national resources. What mainly brought it down to its 1969 dimensions was apparently the budget stringency produced by the Vietnam war, the Great Society program, the riots in the cities, and the fear of continued inflation.

While readers may assess variously the causes for the result, they will recognize that manned space adventure, lofted so ambitiously for the decade of the 1960's, was lacking, in 1969, a program for the 1970's.

CHAPTER VII

CONCLUDING OBSERVATIONS

The authors accepted the utilities and limitations of an historical narrative in undertaking this case study for the Inter-University Case Program. We believed there would be in this case history useful supplement to others. As political scientists, however, we were unwilling to write history alone, for we view it as urgent that data be related deliberately to large issues of human achievement through politics. We chose, therefore, also to suggest to the reader lines of inquiry into the relevance of data about decisions in our political system. We did this with consciousness, first, that the case chosen was so large and complex and the methods available for studying it so diverse that an historical presentation would present an incomplete picture; and second, that the data in a single sequence of decision-making would illuminate only imperfectly the quest for an informed intellectual posture toward the issues raised.

With conscious presumptiveness, therefore, we posed large and meaningful issues about the capability of the political system in face with scientific and technological explosion. We asked with some redundancy, "Can technology and science be combined with government on behalf of the community?" (p. 1) "Can the political system have the capability of handling the multiple and complex issues toward fulfillment of human purpose?" (p. 9) Can there be "a viable politics of social utilitarianism," "a politics of vision toward social goals" (p. 24), "a politics of social planning?" (p. 23) Can positive goals be defined and actions specified for use of science and technology in accord with a future vision? (p. 23) Can politics be more than reaction to current situations and response to elitist or pluralist configurations of power?

We believed that linkage of the events in the case history with these global issues required extrapolation of the kinds of factors that could be expected to have an influence on the course of decision. We set up a construct ("model") of such factors, in which they were divided into structural, arena, and contextual factors, and in Chapters II and III elaborated each of these as relevant to post-Apollo manned space decisions from 1962 to 1968.

We now return to the construct and to the global issues. While we cannot presume to execute here a detailed analysis of all the intimations of knowledge in the case history, it is both appropriate and possible to suggest linkages between contextual and structural factors and the decisions on a post-Apollo manned space program and between these factors and the issues of capability of the political system.

The Impact of Contextual Factors

If the student or other reader looks at the internally-decided technical aspects of the decision as to what shape the post-Apollo manned space program would take, he can discover a rich and complex array of illustrations of the impact of "contextual factors." But even a cursory analysis of the evolution of the hardware configuration that was selected for post-Apollo shows the force that the situation, environment, and perceptual images, which make up the "context" of a decision, can have on it.

It is clear, for example, that while the 1960 and 1963 "long range plans" were based on narrow participation within the agency, they did capture a number of aspects of the perceptual image that shaped post-Apollo planning: the idea that the "purpose" of the manned space flight program was simply "demonstration of a capability," with the real benefits unknown, was in the plans and persisted in post-Apollo thinking. Both plans were bold and dramatic--as were the early concepts of post-Apollo. Two other aspects of the 1960 plan revealed particularly important parts of the agency's policy image: that funding would grow and then level off at the peak expenditure point for the Apollo program, thus leaving a substantial amount of funding slack for which a "program of opportunity" could be designed; and that the "modular design principle," which dominated the thinking of the Houston Center in its contributions to post-Apollo and became a source of controversy in the wet-workshop issue, was the long-range hardware design parameter for the agency.

Kennedy's manned lunar landing decision had some similarly obvious, although indirect, impacts on post-Apollo planning. It meant a huge and rapid uprating of the agency's contracting and operations capability and almost unprecedented budgetary security and affluence, which created a basis for optimism about the future that matched the assumptions of the early long-range plans. At the same time, it created a time frame constraint that set many influences in action on the lunar landing mode decision.

The lunar landing mode decision, in turn, had direct implications, both administrative-political and technical, for post-Apollo. One outcome was the implicit but major professional defeat for Werner Von Braun that the mode decision marked. One reading of the evidence would say that both Von Braun's engineering philosophy and the stakes of the Marshall Center were overturned in this decision. But in bureaucratic politics at the top to lose and "go along" with the corporate decision is often to incur "credit" that will be paid later. Von Braun outlined his notion of the kind of payment he wanted when he insistently urged in the mode decision report that development of an automated Saturn V lunar logistics supply system be carried out parallel to that of Apollo. This demand, of course, was the source of the US-AES studies that led into AAP. When the Saturn V LLS plan did not "make," the "debt" to Von Braun, budget constraints, and the obviously serious imbalance of work that was developing at the Marshall Center put a heavy bias in motion for Von Braun's Saturn IV wet-workshop idea for AAP--enough of a bias to overshadow technical concerns and unknowns voiced by PSAC and the Houston Center. (The influence of this context, as it was set largely by the situation at Marshall, perhaps can be seen also in the solar telescope mounting decision, which was very much a benefit to the work load problem at Marshall.)

What must have been another bias in favor of Von Braun's concept for post-Apollo was the Air Force space station plans. The Air Force plan to seek funding for an intermediate size, manned space station built from existing components perhaps was viewed as a threat by NASA, that is, as an attempt by the Air Force simply to wedge itself into the space field between Apollo and the giant new space station that it thought NASA was planning. This view must have seemed especially credible in light of the fact that when the Air Force began formulating its plans, it had no objective for its space station yet in mind. Given the plausibility of this view, the intermediate size, inexpensive wet-workshop concept must have seemed an attractive response for NASA to the Air Force challenge.

No doubt the most powerful contextual factor shaping the post-Apollo thinking of the agency, however, was the physical existence and functioning capability of the Apollo hardware itself. It could be said that in the most important respect the crucial decision that was faced in post-Apollo planning was the extent to which scientific exploration, particularly for Earth benefit, was to play a role in the program. At the most general level, this was the issue of OSSA versus OMSF.

And at this level, the costs sunk into and demonstrated capability of the Apollo system constituted an overpowering policy premise: it is there; use it; build on it. Counterposed to this was a program of scientific experimentation: undramatic, abstract, and only remotely connectible to direct payoffs. At a lower level the issue took the form of such things as experiments payload development and AAP-IA. It is clear from the case history that the technological imperative, which is toward development and demonstration of capability, at the level of technical planning can overpower the imperative toward science and utility.

The illustrations of the impact of contextual factors in post-Apollo decision-making are not limited, however, to the technical shape of the program emerging from the agency midstructure. Similar but also conflicting impacts are discernible in the political superstructure of agency leadership, the President and Congress, where the technocracy's proposals might or might not fly. Technological superiority as a requirement for national security had been the theme of the post-Sputnik reaction and the lunar landing decision. This perception of threat and faith in the dynamic of technological advance produced for Webb the basic motivation for the next move in space exploration. For him the Saturn capability offered the target of opportunity; the precise configuration of the hardware, crucial in the deliberations of the technical substructure, and the nature of the missions, important to the scientists, were incidentals to larger purpose.

But technological capability, accompanied even by the continued perception of Russian threat, was an uneasy base for political response. On the one hand, in the form in which the post-Apollo program was proposed there was no prospect for a large technological leap and demonstration such as produced the consensus for the lunar landing goal. A manned mission to Mars was too bold for the moment, and the feebleness of the technological thrust in the post-Apollo program could become a rationale for Congressman Fulton's attack. On the other hand, technological capability had so enormously exceeded comprehension of utilities for its use that ambiguity about the latter created uncertainty on the directions for policy.

The reader of this case history may see that in the technological conservationalism and the ambiguity about possible uses for the technological capability led to a basic weakness in political appeal. At the same time, he will see that the opportunities for political success were affected by a further contextual factor: the limitation of resources in the time-frame of decisions. The assumption on which post-Apollo planning had been predicated--that space expenditures would be sustained at the peak attained in the Apollo build-up--was reasonably optimistic in a favorable budgetary climate, but did not anticipate the context of war and urban crisis and their effect on the resources available for space programs. When the funding for NASA became tight, the firm resolve to allow no encumbrances against the Apollo time-table pinched the post-Apollo ventures into their ultimate meager dimensions.

The reader may be attracted by the possibilities for analyzing the effect of specific contextual factors on technological, administrative, and political decisions, or he may be more impressed by the interweaving of the variety of contextual factors in a decisional course that leads towards an unpredictable outcome. Our own preference is to speculate on the implicit significances for the capabilities of the political system. Immediately, however, attention should be directed to the impact of structural factors.

The Impact of Structural Factors

As is typical of organizations, NASA's internal structure was comprehensive and designed to give attention to the diverse aspects of its task, which encompassed manned and unmanned space projects, science applications, and advanced research. Typically, also, it was specialized in a pattern that had continuity. Yet, less typically of organizations, it was an unbalanced structure. The size and priority of the Apollo project, which necessarily required total direction and coordination, gave OMSF superior size, manpower, monetary resources, and internal weight in the organization. Moreover, several factors combined to create opportunities in OMSF--both at headquarters and in centers--to initiate and finance new studies that could emerge in plans for future development: specifically, the discretion allowed to NASA by the authorization and appropriation acts, the autonomy that NASA operations allowed to OMSF and the centers in use of funds, the phasing of project planning, and the spinoff of technological possibilities from the Apollo project. Conditions were favorable for the forward thrust of research and development, as well as for those developments that were spinoffs from Apollo.

Finally, the structure tended to preserve the capability orientation of manned space planning. OMSF and its supporting contractors were manned by technologists, but it was forced also to test the capability of man himself for sustained space operations; at the same time, it was poor in resources for analysis of scientific and utilitarian payoffs of space flight. The payoff aspect was separately structured in OSSA, whose personnel came to see great advantages in unmanned space development, and whose participation in manned space flight had to conform with and be subordinated to the capability testing of manned space flights.

The political superstructure in which NASA programs were considered exhibited the usual features of the political system: a political head of the agency, annual considerations of program in the Bureau of the Budget, special advisory agencies for the President (in this case, the Aeronautics and Space Council, the Office of Science and Technology, and the President's Science Advisory Committee), the Congress and specialized program committees and appropriations subcommittees. The process of annual authorization of expenditures by Congress is somewhat atypical, although it is becoming more common. The linkages that formed a manned space family appear to be strong, but such linkages in subsystems are characteristic of informal political structure. The lack of unity and strength in clientele support may be noted as an additional factor of significance in the informal political structure.

The reader may wish to think about whether there were aspects in the operations of the formal and informal political structure, or in the behavior of individuals within it, that were peculiar for this case in such a way as to make it atypical, or that indicate any significant distinctiveness in government operations with respect to science and technology as compared with other areas of public policy. We suggest that the quality of technological orientation exhibited in the contextual and structural influences and the general typicality of the operations within the political superstructure, as these things are revealed in this study, demonstrate the value of the case in pointing up the general issues about the nature and capability of the political system in confrontation with scientific and technological change. To these issues, as set forth in Chapter I, we now return.

The Nature and Capability of the Political System

The reader may conclude that this case offers evidence to support an elitist interpretation of the political system. He may see that options for choice are foreclosed by the initiatives, constraints, and decisions within a technostructure. Thus, he may see the capability for "a viable politics of social utilitarianism" seriously limited by tendencies in technical planning and configurations of power deep within a technostructure and obscured, at least at the stage where options are being formed, from outside view. (In this connection it may be noted that some of the most important documents setting the context for post-Apollo planning were classified, and not declassified until pressure was exerted by the authors of this study.) He may see also evidence of a self-propelling tendency and of incremental development within a technostructure, and even of options being decided through the internal politics of the technostructure. The reader also may see evidence of a technostructure extending its influence externally to create a functional political subsystem ("functional oligarchy") within which supports for the technostructure and the options it presents are generated.

Alternatively, the reader may find in the case support for a pluralistic interpretation of the political system. He may see conflicts in interest and in perception of goals internally in the technostructure--both within the OMSF and between OMSF and OSSA--and compromise or union of contending claims. He may see these same conflicts in the clienteles--scientists and contractors--who have intense interests. He may see these reflected also in the Congress and its committees. He may see the President and the committees of Congress maintaining compromises among competing claims, especially by keeping alive the options desired by each claimant from year to year.

The reader indeed may see no exclusivity in these two interpretations. He may see strategic advantage in the position of the technostructure and yet see its advantage dissipated by its own disunities or lost in external division and confusion. Beyond this, and this may be the meaning of the events in this study, he may see that both interpretations point up the limitations of the political system in confrontation with change.

The system could react positively to threat in 1961, with a decision that was durable through the decade. Lacking such a threat, and facing a situation that called for redefinition of program, its agenda was limited to incremental options. The structure of the system itself fostered business on the basis of incremental options: annual budgets, annual authorizations by program committees, parallellism between the structure of congressional committees and the agency offices. These were supplements to whatever normal tendencies might exist toward self-maintenance in the technostructure and its offices, centers, and contractors.

Incrementalism can be recognized as having an appropriate function in advancing public programs. It can be seen also that time may be an important contextual factor in determining the political opportunity for non-incremental options. This was undoubtedly true in this case, for the tax reduction bill, riots in the cities, and Vietnam expenditures made bold new adventures in space untimely. Yet untimeliness, like absence of threat, may be seriously dysfunctional if it prevents vision of options for social utilitarianism for a future span.

It will be recalled that Webb wanted to obtain attention in the macropolitical forum to long-run goals for a space program. He desired a "national consensus" developed on the basis of national discussion. This may be necessary for "a politics of vision toward social goals," but the national debate never happened. For gaining such a debate one may see limitations in the story told here that are significant with respect to the capabilities of the political system.

Basic is the problem of attention. When Senator Smith noted that her public was not interested in space, Webb retreated to reference to discussion among the political leaders. Yet political leaders give attention to what their publics are interested in; generally, the citizen is overloaded with political issues and poorly reached by the communication system. In the absence of threat, there is a tendency toward dormancy in public attention to any specific area of public policy. Failure to awaken public interest in the area invites elite manipulation and control of political decision centers, and weakens the interest of political leadership.

Vital for attention and discussion is the framing of the options to focus positive social benefits that may be gained. The reader may have contemplated throughout this story whether there was substance in AAP for positive social achievement. We suggest also that he should reflect whether the structure of the planning system itself, decentralized to technicians operating under constraints from self-sustaining centers of influence, prevented the dominance of perspectives of social benefit. He also will want to think of the response of the political superstructure to the program: accepted at the top of the agency, viewed with skepticism and trimmed by approximately one-third its prospective cost in the crucial consideration of the FY 1968 budget in the Bureau of the Budget, and engaging in the Congress a narrow base of loyal support for the administering agency but a broader rejection. He may see in this gauntlet a political system that supplies successive centers for potential negative action on options coming from the technostructure, but he may view also with serious concern the inability of the political superstructure to create any additional options. He will see the President asking for a program and a program emerging from the technostructure. He will see also the failure of the National Aeronautics and Space Council to develop, as mandated by the Space Act, "a comprehensive program of aeronautical and space activities." He may see, further, the congressional committees immersed in the detail of annual authorizations. He may ponder, therefore, the capabilities of the political superstructure as it now operates to concentrate attention on planning for social goals.

But, if indeed the deliberations were narrowed by the options, were they also confused by the contextual factor of perceptual uncertainty? The options that were presented were clear, but the ambiguity on purpose that characterized the nation's space effort from the beginning precluded the consensus that Webb perceived as necessary for a sustained, positive space program. This indeed may have been the crucial weakness in the discussions about the space program of the future.

We suggest, in concluding this discussion, that this case study shows that John Stuart Mill's prophetic vision defined the problem of capability of the modern political system: how can the "bodies representative of the entire people" confront the capabilities presented by the organization of knowledge and skill. While means of reform of the political system was not the purpose of this study, we suggest that the directions for reform should be shaped by response to two questions: First, can the representatives of the entire people penetrate into the shaping of the options that determine the issues for discussion? Second, can the focus of the deliberations of the representatives of the people be lifted from annual incremental adjustments by "a politics of social planning?"